

W. C. Mylne.

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A
T R E A T I S E
O N
B U I L D I N G I N W A T E R :
I N T W O P A R T S.

P A R T I.

Particularly relative to the Repair and Re-building of ESSEX-BRIDGE, *Dublin*, and Bridge - Building in general; with Plans properly suited to the Re-building of ORMOND-BRIDGE.

P A R T II.

Concerning an Attempt to contrive and introduce quick and cheap Methods for erecting

substantial Stone Buildings and other Works, in Fresh and Salt Water, Quaking Bogs or Morasses, for various Purposes; fully laid down, and clearly demonstrated, by Twelve PRACTICAL PROPOSITIONS, but not in any Case exceeding Ten Fathom deep: Together with a Plan for a spacious and commodious Harbour for the Downs in *England*, projecting to Twenty Feet deep at low Water.

T H E S E C O N D E D I T I O N .

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P A R T III.

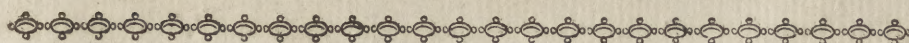
HIBERNIA'S FREE TRADE; or, A Plan for the general Improvement of *Ireland*: peculiarly adapted for Improving the Commercial

and Landed Interest of *Ireland*; and briefly demonstrating, that not only *Great Britain*, but the whole British Empire, may gain proportionable Advantages thereby.

Illustrated with Sixty-four COPPER-PLATES.

By G E O R G E S E M P L E.

Bid HARBOURS open, PUBLIC ROADS extend,
And TEMPLES (worthier of the GOD) ascend;
Bid the BROAD ARCH the dangerous Flood contain,
The MOLE, projected, break the roaring Main;
Back to his Bounds their Subject SEA command,
And roll obedient RIVERS thro' the Land:
These Honours PEACE to happy BRITAIN brings;
These are Imperial Works, and worthy Kings. *Pope's Epist.*



L O N D O N :

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M, DCC, LXXX.

T O
T H E K I N G.

S I R,

YOUR Majesty has been constantly considered as the Friend and Patron of the *Sciences* and the *Arts*. The eminent Virtues that beam from *Britain's* Throne, would have rendered a private Station illustrious, and dignified the Scholar and the Man. To whom then can I, with such Propriety, inscribe these Sheets, as to a Monarch, who is peculiarly interested in the Subject of the most important Part of them, that of a “Plan for the general Improvement of “your Majesty’s Kingdom of *Ireland*?” I lay them, with the utmost Deference and Humility, at your Majesty’s Feet. They are the Fruits of a close and unremitted Application of twenty-seven Years. Should they be thought deserving the slightest Attention of your Majesty, or induce any of your Majesty’s Servants to think the Plan I have designed may be conducive to your Majesty’s Service, I shall think those Years the best employed in my Life; and, in the Evening of my Days, reflect, with a peculiar Degree of Satisfaction, I have not lived in vain.

I am, with the most dutiful and profound Respect,

Your MAJESTY’S

Most loyal and faithful Subject and Servant,

GEORGE SEMPLE.

THE KING

YOUR Majesty has been graciously condescended
 to my humble petition and I am most deeply
 indebted to your Majesty for the favour of your
 Majesty's command that I should be permitted to
 attend upon your Majesty at the Palace of St. James's
 and to be admitted into your Majesty's presence
 and to be permitted to be employed in your Majesty's
 service. I am most deeply indebted to your Majesty
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 permitted to be employed in your Majesty's service.

I am with the most dutiful and profound respect,
 Your Majesty's most obedient servant,
 GEORGE SEMPLE

T H E
A U T H O R
T O T H E
R E A D E R.

BEFORE I attempt to engage your Attention, I think I ought to apologize for presuming to treat on Subjects of such great Importance, and far above my Capacity; I shall therefore assign the Cause of my engaging in them. They were occasioned by a particular Incident that occurred in my conquering all Difficulties in building *Essex-Bridge*.

In the Year 1755, having made a convenient Carriage Road over it, many Gentlemen were pleased to congratulate me on my good Success, amongst whom were several of the Right Honourable and Honourable Commissioners of the Inland Navigations; who informed me, that if I chose to be concerned, they would get me nominated as Controuler of those Works, and that my Department should be to inspect into the Works of all the *Canals* in the Kingdom, to make my Reports to their Board, and to take Care that all the Locks, Bridges, Aqueducts, &c. were effectually executed, &c. I shall not trouble you any further with this Affair, but only observe, that after I had been at great Expence, I was shamefully circumvented.

In the Winter of that Year, some very warm Debates happened in Parliament, concerning the Navigation from the *Liffey* to the *Shannon*, some were for the *North*, and some for the *South* Lines. My private Opinion was asked by those on both Sides of the Question; but not having applied my Thoughts to any Thing of that Nature, and not choosing to give a rash Opinion, I set off, and took a cursory View of all the Rivers worth my Notice, between *Dublin* and *Cork*; thence to *Limerick*, and traced

traced the Course of the *Shannon* on the *West* Side, crossed at *Eyrecourt*, and came Home by *Tullamore* and *Philipstown*: And on my Return, having compared the Opinions of several Gentlemen that were employed and had wrote on it; upon the Whole I was not able to determine which of those Lines ought to obtain the Preference; nor do I to this Day believe, that either of them has been fully considered; but I am determined not to depreciate that most useful Improvement.

Through the Whole of this little Tour, you may depend upon it, that my Imagination did not get much Sleep; I had Variety of Objects to entertain it, many of them exhibiting rude and doleful Prospects through Poverty and Neglect, which I hoped would be at some Time or other taken into public Consideration: And these, and the like Thoughts, spirited me up to give them free Entertainment, and induced me to collect all Kinds of Materials for this Purpose; and to that End I frequently revised my Diary of the Work I then had in Hands, well knowing that many of the Methods might prove extremely useful in future; and as they had never been published in *English*, I thought it incumbent upon me to deposit them in the Hands of the Public, which led me at leisure Hours, after that Work was accomplished, to form Schemes and Plans for a general Improvement of the Kingdom, with which I was very well acquainted. But those Designs were soon interrupted; for the excessive Colds, and extreme Application to that most arduous Task, fell so heavy upon me, that my whole Frame was, as it were, dislocated, and I was disabled from doing any Kind of Business, and obliged to retire to the Country in a deplorable Condition, and was often so ill, that I could scarcely go across my Room, but was particularly afflicted with the Gravel and Rheumatism; yet I carefully preserved my Notes and Sketches during the Space of ten Years, and at length having, in a great Measure, got the better of some of my Disorders, I returned to Town, and according as I found myself able, proceeded with Alacrity, and to the utmost of my poor Ability, engaged in the First and Second Parts which now lie before you, as they contained the most

most necessary Matters I could devise, for those or the like Purposes, either in this or any other Country. But I must beg Leave to acquaint you, that from my earliest Days, I was employed to do Things, and not to write upon them; for, in Truth, the Whole of my Scholarship, except what little I got whilst I was a meer Child, was acquired within the Compass of six Winter Weeks, in the thirteenth Year of my Age. Having therefore made this ingenuous Confession, I must hope that your Generosity will protect my humble Work from the Censure of ill-natured Critics. However, in order to shelter myself, I was driven to the Necessity of contriving to delineate my Ideas, rather than to convey them or my Sentiments by Words; and that is the Reason of my having gone to the Expence of engraving so large a Number of Plates for so small a Book: In the First and Second Parts of which, the bare looking at some of those Plates will be abundantly sufficient for some People, as it was for me, when I had the good Fortune of meeting with Colonel *Belidore's* Hydraulic Architecture, as you will find mentioned in Chapter IV. from which, within the Space of only one Minute, I clearly comprehended the very Thing that I had travelled *England* in Quest of, to no Manner of Effect.

It is generally admitted, that in all the Arts and Sciences, we are at least one hundred Years behind the *French*. Is it not wonderful then, that the Art of working in Coffer-dams should be, through the Supineness of our learned Gentlemen, totally neglected? I have related the wretched Situation I was in for want of that Knowledge, which I acquired in so short a Time, by barely looking at Plate 8, in my Book: And had not Providence thrown that in my Way, I most certainly should have miscarried in my Attempt, which probably might have cost the City five or six thousand Pounds, besides the infinite Difficulties that might attend their ever getting a Bridge effectually built in that Place afterwards.

Having with some Difficulties accomplished these two Parts, I found it advisable to postpone my general Plan for the Improvement and commercial Interest of the Kingdom, well knowing,

that all the Expectations we formerly entertained, of our getting a *Free Trade*, had dwindled and died away for many Years past. To what Purpose then should I be at the Trouble and Expence of publishing a Scheme that did not seem to be so much as in Embryo? But, in the Beginning of the present Sessions of Parliament, a *Free Trade*, which certainly we had a Right to derived from HEAVEN, and which no Kingdom on Earth could legally withhold from us, being granted, I thought it high Time to proceed in that Work; but as I could not explain the Remainder of my Plans by Delineation, and knowing that it was absolutely necessary to offer some Arguments in the Support of the Rectitude thereof, with Respect to the Manufacturers and Artisans of *Great-Britain*, I used my Endeavours to throw the best Things I could devise into the public Scale; but that Affair went on with such Rapidity, and passed so suddenly, that I was not by any Means able to keep Pace with them; but now, as the Act has passed, the greatest Part of the Arguments and Allegations I had prepared are rendered unnecessary; yet I still think, that as my Plans are of a peculiar Nature, I ought to offer some Reasons in Support of them, so that nothing may be omitted that might conduce toward the reconciling and uniting both the Affections and Interest of all his Majesty's Subjects; as it is to be ardently wished, that such a happy Reconciliation may be permanently settled between them: And with that Intent, I have endeavoured to order my Plan in such Manner, as to leave no Room for Complaints, in any Case where Reason shall be attended to, and followed. But, please to observe, that I have not studied to contrive an Amusement for you, as I thought it would be more useful to offer something instructive.

But, I am aware that perhaps I may be suspected of forming this Scheme, to involve the Nation in an immense Expence, to answer some pecuniary Purpose. Now, to what I have offered above, I think it is necessary that I should declare my true Sentiments on these Affairs, and that I am entirely disinterested in all Respects. I shall therefore apprise you of the true Principles on which I have formed my commercial Plan, *i. e.* on a well grounded Hope,

Hope, that by our being established in a *Free Trade*, we may give immediate Employment to our Poor, make our Country flourish, and exalt the *British* Empire, and thereby secure her Colonies and Settlements in future : And that if ever these salutary Purposes are effected, I apprehend it must be by bringing *England*, *Scotland*, and *Ireland*, to be considered as one Nation in Trade and Commerce. Woeful Experience has taught us that we ought to be so ; for if we cross one another's Interest, and put Bars and Impediments in one another's Trade and Commerce, we do not only become as it were Foreigners, but even as Enemies to one another. The Source from whence these Disagreements must flow, may be easily discovered by any Person who can solve this wonderful Paradox, *viz.* " That *Englishmen* lawfully sent over to suppress Rebellions in *Ireland*, should, after having effected the same, be as it were disfranchised and lose their own Birthright in *England*, and be obliged to pay Customs and Duties as Foreigners for all they spend in *Ireland*, whither they were sent for the Honour and Benefit of *England*."—If these Matters are not properly considered, how can any Measures be formed for the Redress of the numerous Grievances *Ireland* has complained of, with Respect to her Restrictions in Trade ? I shall shew you in the proper Place, that *Ireland* alone has more good Ports and Bays, and a larger Coast than *France*, our greatest Rival in Trade ; and if it was improved to its full native Capacity, it would be greatly superior to her : How then shall we endeavour to point out the true Interest of the *British* Empire, or to shew how it ought to be pursued ; but by shewing the strong Connection there is between Land and Trade, and putting all the Subjects of these Kingdoms on the same Footing in Traffic and Commerce, and by that Means to cement their true Interest and Affections together, so as never to be separated ; which I propose to be the principal Business recommended to your Consideration in the Third Part. And I presume to entreat you in due Time, to accompany me with pure and unprejudiced Intentions, and to lend your Endeavours to accomplish these salutary Purposes, according as you may think fit.

In

In my treating on this Subject, I consider it under these two principal Heads, the general Improvement, and the commercial Interest of *Ireland*; and each of these Heads is also to be considered under two other less considerable Heads, which are the interior and the exterior Improvements. All the most difficult Matters that are to be encountered under these two Heads, you will find minutely laid down and explained in the First and Second Parts; and many of the most important Matters concerning the commercial and landed Interest, you will find briefly stated in the Third Part; but to introduce you clearly to the Thread of it, you ought to begin at Sect. V. page 153, because the Conclusion of that Section leads you into the Third Part; in which, if the Plan I have therein laid down, is approved of by the Public, I intend (provided my Health permits) to proceed and treat on three other distinct Matters which may be found necessary to compleat my Book, either in other Chapters, or as a Fourth Part; but if my Plan is not approved of or adopted, to what Purpose should I proceed, as I observed above? It is however proper, that I should inform you what those three other distinct Matters are; of which

First, To lay down such Marks, and other Circumstances, as may guide any intelligent Person to choose proper Sites for either interior or exterior Villages, Towns or Cities.

Secondly, To treat on effectual Methods for collecting and managing fresh Water, &c.

Thirdly, I propose to delineate the Plan of a Granary, to contain 700 Barrels of Wheat, on the Area of sixteen Feet square in the Clear of the Walls, and to keep it perfectly safe for seven Years, if necessary, by Means of a simple Engine, and the Work and occasional Attendance of two Boys; the Expence whereof may be compleated for a very small Sum in Comparison to other Granaries that have hitherto been built in this Kingdom; and by the same Model it may be made to contain more or less in Proportion.

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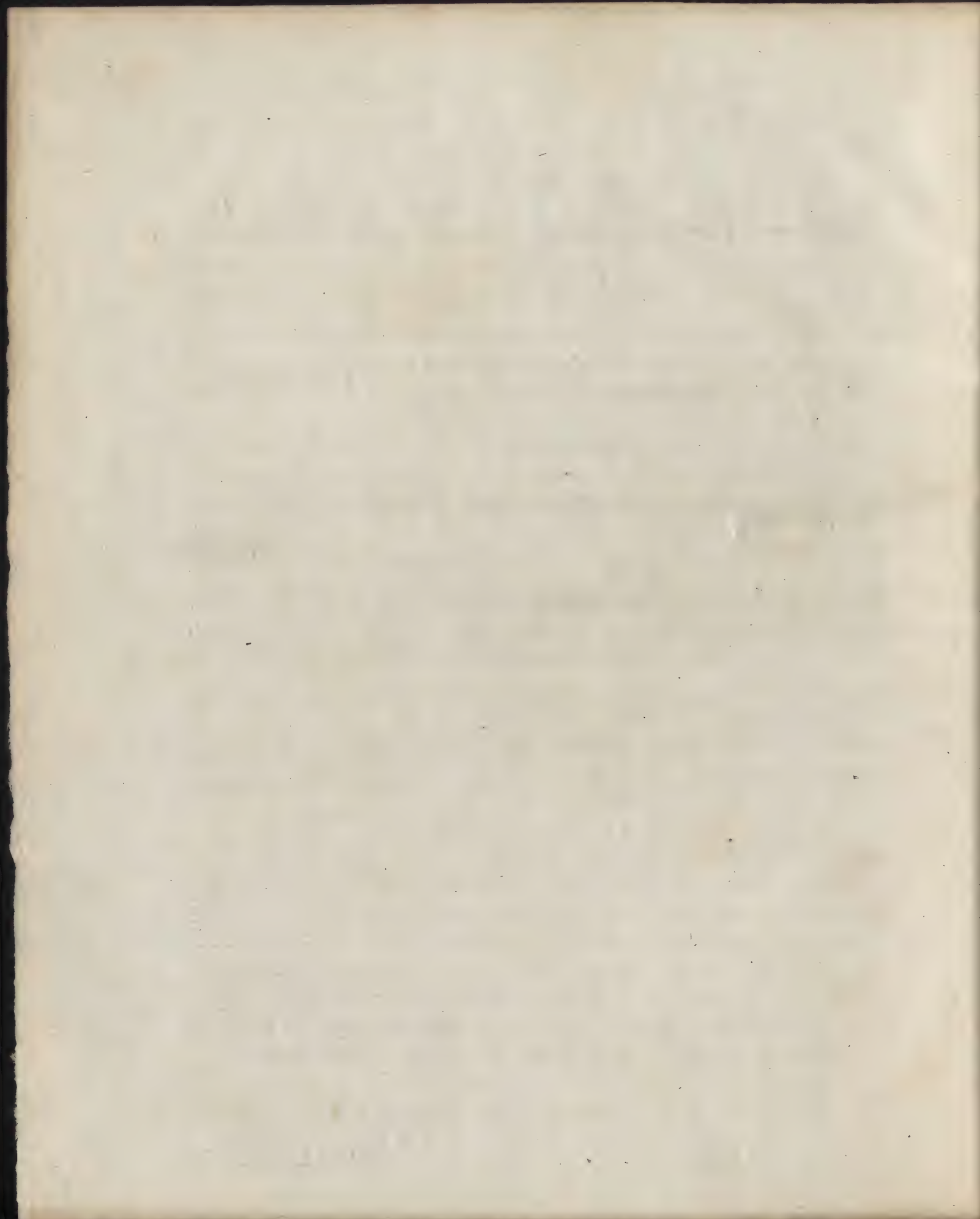
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BUILDING in WATER.

PART I.

Particularly relative to the Repair and Re-building of *Essex-bridge*, *Dublin*, and Bridge-Building in general, with Plans properly suited to the Re-building of *Ormond-bridge*.

C H A P. I.

Concerning the Temporary Repair of Essex-bridge.

IN the latter end of May, 1751, I accidentally met with Mr. *Prior* at his Grace the Lord Archbishop of *Dublin's*, where I heard him very pathetically lament the Loss and Inconvenience the Public sustained, by being near four Months deprived of the Use of *Essex-bridge*: On which his Grace enquired further into that Matter, and was informed, that there were then two or three Schemes lying before the Corporation of the City; one of which, was to repair it with Timber in five Months for 500 *l.* another with Stone, within six Months for 800 *l.* &c. &c.

Mr. *Prior* then earnestly requested my Opinion, to which, I replied, That as I had not taken any particular Notice of it, I could not presume to give my Sentiments; but not being satisfied with that Answer, he pressed me to tell him what I thought of it. On which, I told him, that I did not apprehend there was any Difficulty in making an effectual temporary Repair with Timber; and to further Questions, I instantly answered, that I believed, it might be done within ten Days, for about one hundred Guineas.

On this, he immediately acquainted Alderman *John Cooke*, then Lord Mayor, and from that Time Mr. *Prior* (living contiguous to me) made me frequent Visits, and at length prevailed on me with some Reluctance to engage in it. Accordingly, I began to
B examine

examine the whole Structure, and to prepare for the temporary Repair. See Plate I.

EXPLANATION of PLATE I. *Scale 30 Feet to 1 Inch.*

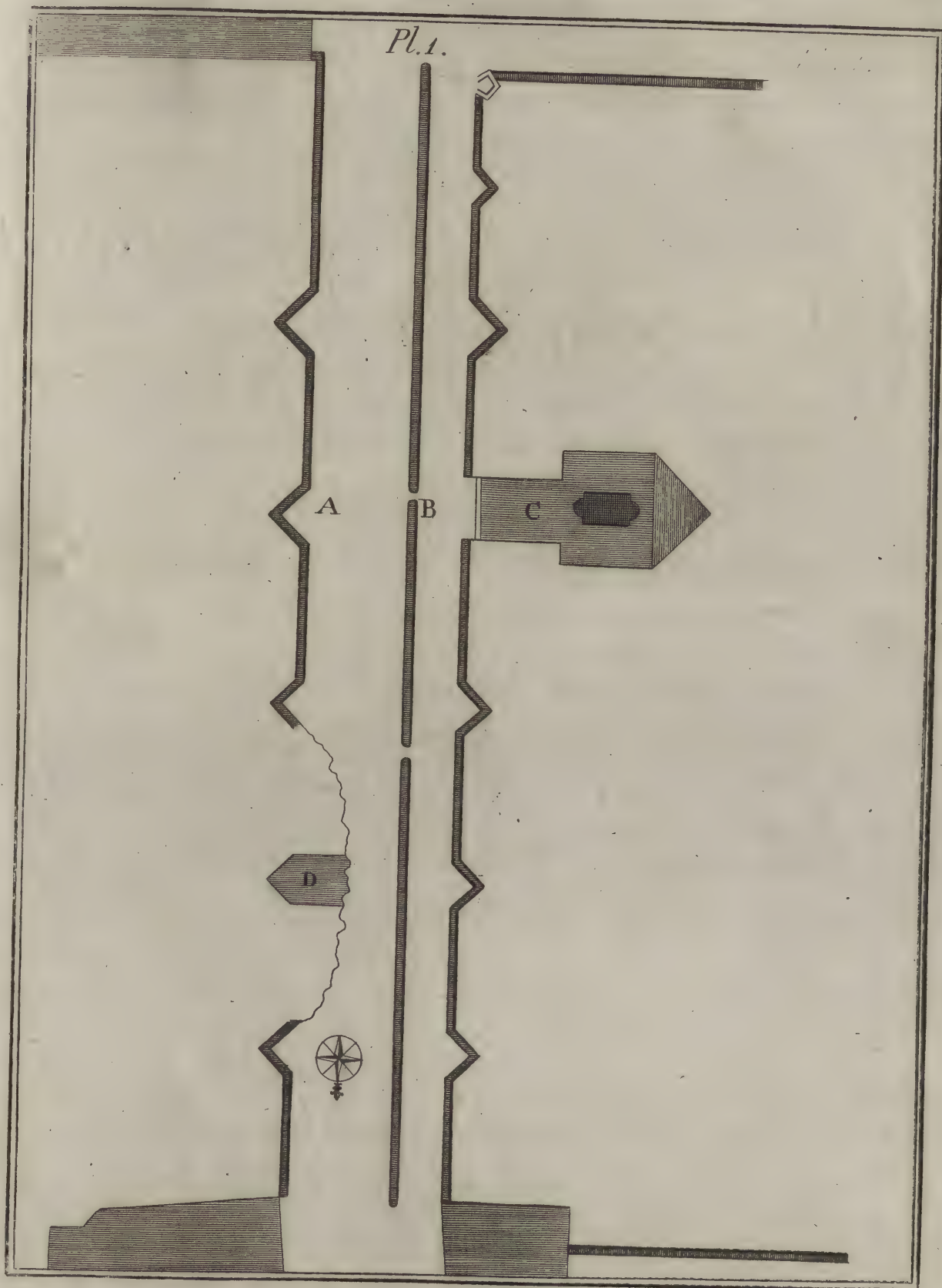
This Plate represents the Plan of the Superstructure, as I found it on the 20th July 1751. Wherein Note,

A. Carriage Way, 20 Feet 5 Inches Broad. B. Foot-way, 9 Feet 5 Inches, on an Average. C. Pedestal of the Equestrian Statue of King George I. D. The Pier that fell down, and caused the Breach in the Carriage-way. See Plate II.

EXPLANATION of PLATE II. *per the same Scale.*

This Plate Fig. 1. represents the East Front of the Bridge to the Surface of the Pavement.

E. The Breach that was made by the Failure of the 5th Pier from the South. F F. Low-water Mark. G. Surface of the Pavement at the Corner of the Excise-office, 24 Feet 2 Inches above the Low-water Mark. H. Surface of the Pavement at the Corner of Mr. Newton's-Shop, 19 Feet 4 Inches above the Low-water Mark. I. Summit of the Pavement 26 Feet 8 Inches above Low-water Mark. N. B. From this Place the Pavement declines 2 Feet 6 Inches to G. and 7 Feet 4 Inches to H. whence it seems as if the Bridge had settled somewhat into the North Bed of the River, which put me upon Examining. K. A level Line taken from the Plinth of the 2d Pier, on a Supposition that all the Arches originally sprang from that level Line: If so, then the third Pier sunk into the Bed of the River (on the Surface of which they were built) 6 Inches; the fourth, 8 Inches; the fifth, 1 Foot; the sixth, 1 Foot 7 Inches. L. Represents that this South Pier is rebuilt on the Ruins of a former Arch that had fallen down. The Surface of the highest Part of the Ruins is about 4 Feet 6 Inches above the Low-water Mark, consequently obstructed so much of the Water-way, and made it incline to the Northward.





Pl. 2.

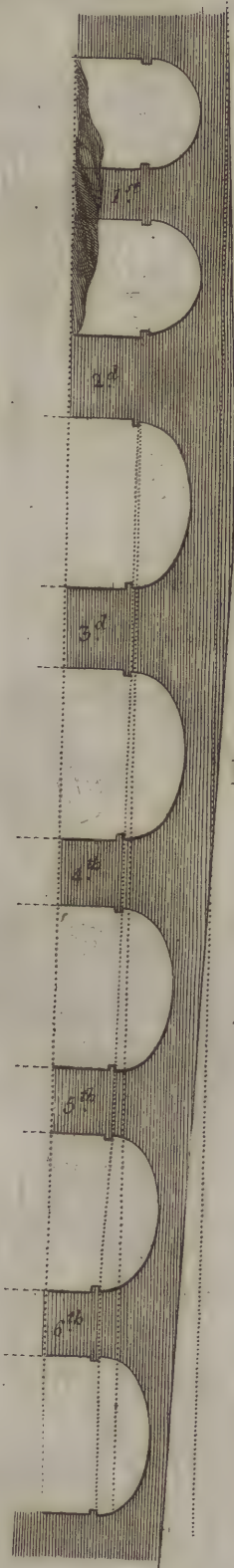


Fig. 2.

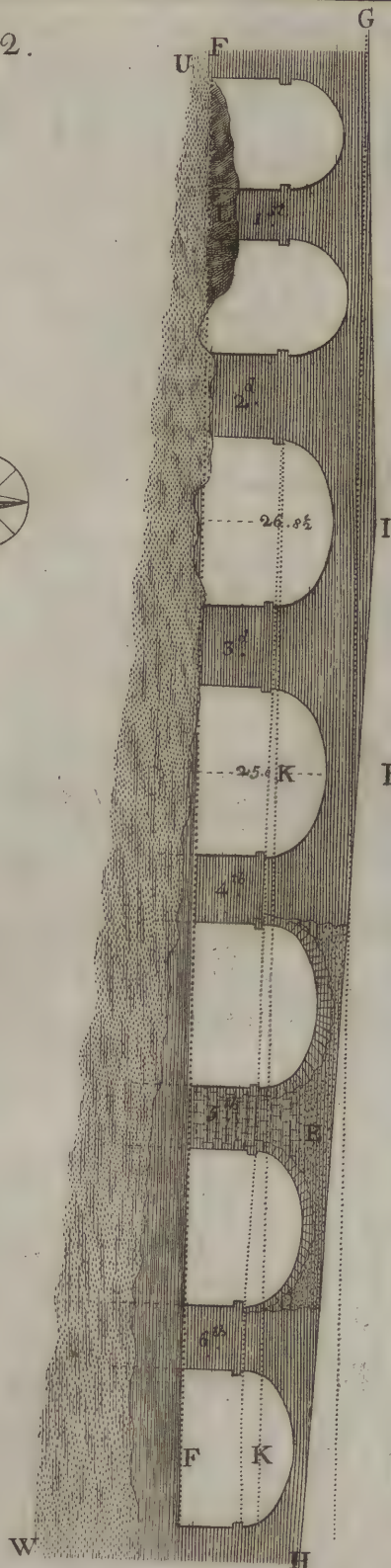


Fig. 1.



In the Year 1676, Sir *Humphrey Jervis* began to build this Bridge (of the Stones of *St. Mary's-Abbey*) and in about eleven Years after, *viz.* On the 4th and 5th of *December* 1687, there happened a very great Rain, and a violent Storm at E. S. E. (which is the likeliest Point to cause high Tides in this River, because both Tide and Land-flood coming together, generally occasions the Tides rising higher in the River than ordinary) and this high Tide meeting with an exceeding high Flood in the River, rose the Water to such a prodigious Height, as quite overflowed the lower Parts of the City: In some Houses the Water rose up to the Parlour Floor, and on some of the Quays much higher, so that Boats plied in the Streets.

At this Time there happened to be a Hackney-coach driving over the Bridge, but providentially there was no Body in the Coach, and as they were just on the Crown of that Arch, the Bed of the River under that Pier being carried away by the Floods, the Pier fell down, and so down came the Arch, Coach, Coach-man and two Horses, and all together were swept down to the Watering-slip. The Man clung fast to the Coach-box, sometimes under and sometimes above Water, till they came to the Slip, where one of the Horses broke his Traces and swam out, but the Man and the other Horse were drowned. And as this happened in the Midst of Winter, they certainly could not conveniently get the Ruins at that Time removed, therefore, they only just rough-levelled them, and built the new Pier upon them.

Fig. 2. by the same Scale, represents the West Side of the Bridge inverted: Wherein observe, that the Plinth of the third Pier from the South, has on this Side sunk from the level Line about 1 Foot; the fourth 1 Foot 7 Inches; the fifth 2 Feet 1 Inch, and the sixth Pier 3 Feet 6 Inches; so comparing these with the same on the East Side respectively, the Cause of this West Side sinking more than the East Side, is obvious, *viz.* That the Foot-way being lately built, and the Workmen taking down the Cut-waters to Low-water Mark, in order to join the Piers of the Foot-way close to it, built Part of the Piers of the Foot-way on Part of the Foundation of the Cut-waters, and the rest of them on the naked Bed

of the River. This was the Cause of the Foot-way being opened, and separated about eight Inches from the Bridge, and the Ground being much softer at the North than at the South end, it yielded and sunk so much the more under it.

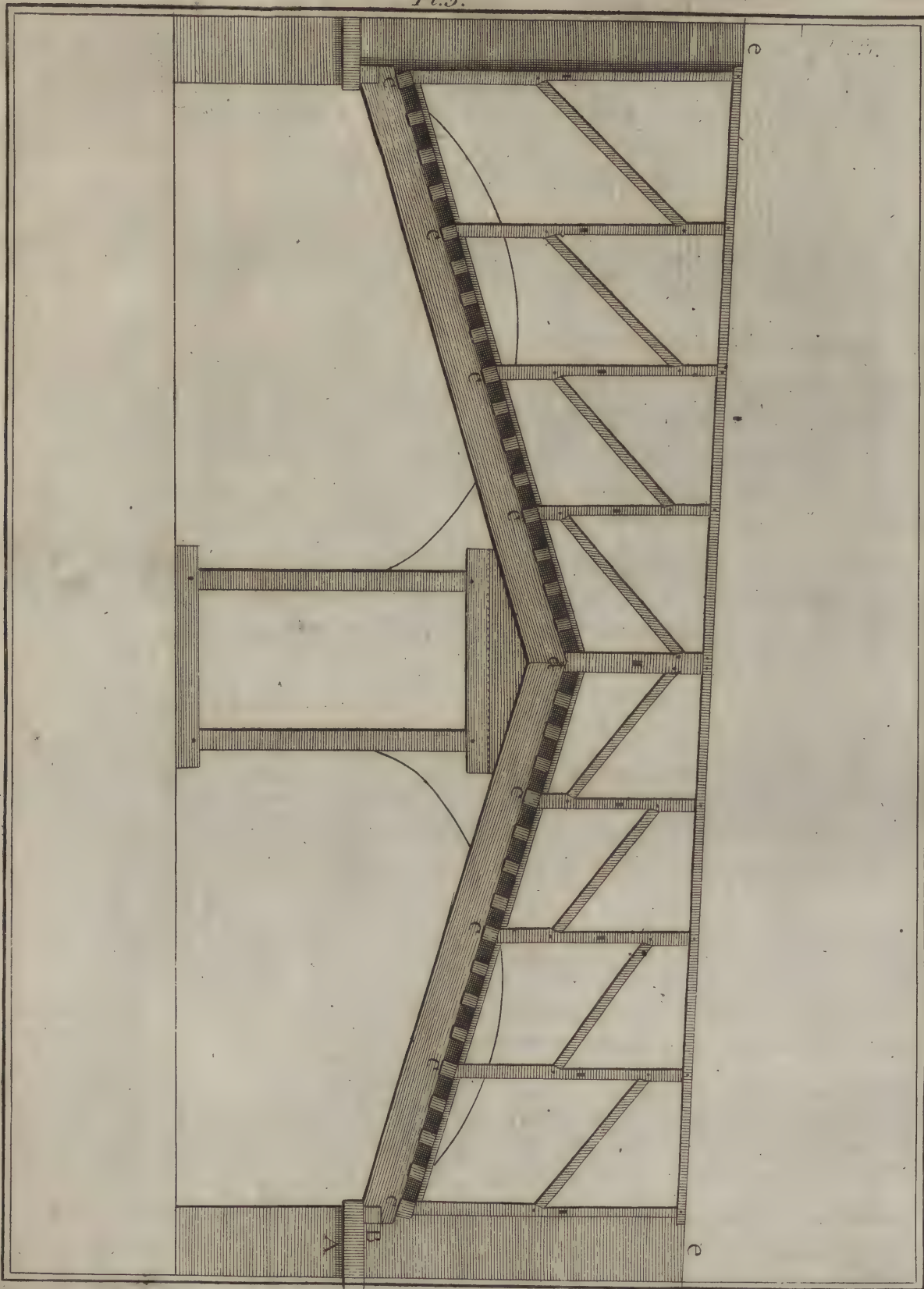
EXPLANATION of PLATE III. or *Temporary Repair, laid down by a Scale of 8 Feet to 1 Inch.*

All that I found necessary for this Purpose, was to clear and square the Breach down to the Plinths A. and thereon to bed the Plates B. on which I lodged the Ends of two Brace-beams of 16 Inches Square, and in like Manner two more Inwards covered with Joists, and floored with three Inch Plank, under which I previously erected two Frames to support them at their joining; and as I was aware that the outward Frame was in great Danger of being swept away by a Flood, I did not engage them to the Brace Beams, which in Truth stood in no Need of their Support. The eight Joists marked c. and the Crown Beams d. projected from three to five Feet, to sustain the Feet of the outward Braces. e. e. Is the Top of the Parapet Wall, and I hope that bare Inspection is sufficient to explain the Rest. On the 30th of the same Month of July, I had compleated the whole, that is, on the 10th Day I laid it open for Carriages, and the Cost did not exceed the Sum of 100 Guineas, as I had unpremeditatedly mentioned to Mr. Prior.

C H A P. II.

Some Preparatives towards drawing a Design for a new Bridge, and Observations relative to Bridge-Building in general.

WHILST I was going on with the Repair, Mr. Prior, several of the Aldermen, and other principal Gentlemen of the Corporation of the City, often visited me, and when they found me near the Accomplishment of it, gave me great Encouragement to engage in rebuilding the Bridge, which somewhat alarmed me, as I was at that Time engaged by Contract in building





building *St. Patrick's Hospital*, two Houses for the *Rev. Dr. Leigh* in *Capel-street*, and one for *Arthur Newburgh, Esq*; I was also engaged in the conduct of the building a new House for his Grace the Lord Archbishop of *Dublin*, and another for Colonel *Ram*, at *Gorey*, &c. However, I found myself extremely inclined to engage in the building the Bridge, though I well knew it would be a very arduous Task.

I had on many Occasions before felt a great Desire to acquire Knowledge in difficult Matters of Arts and Science; and whenever they grew easy and familiar to me, I could no longer perceive in them the Charms which had before captivated me. Interest alone could never sway me in these Researches and Pursuits; but from my earliest Days I had entertained a Notion, that the greater the Difficulty, the sweeter the Conquest. In short, that Subject took firm Possession of me; and I applied myself to search my Books, of which I then had a fine and valuable Collection, and I found in them numerous elegant Designs; but as touching the laying a Foundation in deep and rapid Rivers, all the Authors were in a Manner silent.

This Deficiency in so many excellent Authors, greatly amazed me; and in Hopes of procuring better Instructions, I settled my domestic Affairs, and went to *London*, where I procured about 40*l.* worth of Books, Plans, &c. which I ordered to be sent after me, and returned Home within the compass of fourteen Days, full of Hopes that by their Assistance, I should be able to pick out something for my Purpose; but after I had attentively perused them, I found myself in the same Situation I had been in before.

I cannot describe the Indignation and Sorrow I felt, at finding an Art of such public Utility, as that of building Bridges confessedly is, so shamefully neglected: However, these Books furnished me with many useful Hints, and Observations, some few of which, I shall give for the Improvement of the young Student, and as necessarily connected with the Subject I am treating.

S E C T I O N I.

Historical Accounts of some remarkable Stone Bridges in foreign Parts.

IT has been a Rule laid down by the Writers on Science in general, that Excellence in any particular Branch is only to be acquired, by attentively and diligently perusing and digesting the Works and Designs of the most eminent Authors and Artists; but the young Student should always be on his Guard, when he is about designing any Thing, that a too lively or over-heated Imagination does not lead him into Chimeras, which sober Judgment would not approve. This Error may be in a great Measure avoided, by paying a proper Deference to the Sentiments of learned Men. For my Part, I think a young Man will gain greater Reputation by being an humble Copier of an ingenious Artist, than to pretend to excel every one by the Fertility of his own Imagination. But in such Matters, where you cannot be furnished with Precedents, you are under a Necessity of striking out something from your own Brain. Yet these are not to be abortive, mishapen Beings, the mere Creatures of a wild Fancy, but the fair, the legitimate Offspring of a well-regulated Judgment. This Observation deserves to be well attended to in all Cases; but particularly in those where a Miscarriage may be attended with fatal Consequences.

There are an infinite Number of Bridges over the natural and artificial Rivers in *China*. We shall content ourselves with observing one of the most famed, which is the Stone Bridge over the River *Saffrany*, which joins two Mountains together, and is in one single Arch, which spans 600 Feet. From its Foundation to the top of the Parapets is 750 Feet, and from the exceeding great Height of it, Travellers have given it the Name of the *flying Bridge*. There is another very remarkable Stone Bridge at *Oxu*, the Capital of *Fo-kin*, which consists of 100 Arches. But as we have a long Journey before us, we cannot make any further Remarks on the Bridges in *China*, and therefore, we must make large Strides, and step over to the *Danube*.

The

The next enormous Bridge I shall mention, is that which the Emperor *Trajan* had built over the *Danube*, in order to convey his Troops with the greater Readiness to fall on the Barbarians; but I find a great Disagreement among the Historians concerning it.

Some say, this Bridge was one of the most amazing Works in the World; but they generally agree, that it was composed of twenty Arches, nineteen Piers, and two Land Abutments, all of solid Masonry; each Arch was 170 Feet Span. The Piers, we are told, were 60 Feet broad, and 150 Feet high; that each of the Land Abutments was 120 Feet (which is twice the Thickness of the Piers) that the Arches were all true Semi-circles, and that it was built where the River was narrowest, and consequently the most rapid, which renders the Fabric still more stupendous and amazing, on Account of the prodigious Difficulties they must have met with in laying the Foundations. But some relate that the ten outward Piers were built on an artificial Foundation, made by wheeling in vast Quantities of large and small Stones, and other filling, after the usual Manner of carrying a Mole into the Sea, but they form not the least Conjecture, how the Piers were erected in the middle of the River.

The Architect employed on this Occasion was one *Apollodorus* of *Damascus*, who it seems, left a Description of this great Work, which (the Historian says) may be seen in *Procop. de Aedificiis, Justin, B IV. c. 6*. But when *Adrian* came to be Emperor, he ordered the Arches to be demolished, to prevent the Barbarians making Excursions into his Territories. But *Dion Cassius* relates, that the Piers were standing in his Time, which was 120 Years after the Bridge was built; but when it was entirely demolished, the River was so choaked up with the Ruins, that it was not navigable, which obliged them to make a new Channel for it. We shall treat of this no further at present, but proceed in more useful Enquiries, and see what some of the most eminent Architects have left us concerning Stone Bridges.

S E C T. II.

A short Abstract from LEON BATTISTA ALBERTI,

THIS Author in his 8th Book, Chap. 6. Page 62. says, the Parts of the Bridge are the Piers, the Arches and the Pavement, or the Street in the Middle for the Passage of Cattle, and the raised Causeway on each Side for the better Sort of Citizens, and the Sides or Rails, and in some Places Houses too, as in that most noble Bridge, called *Adrian's Mole*, a Work never to be forgotten; the very Skeleton whereof (if I may so call it) I can never behold without a Sort of Reverence and Awe. It was covered with a Roof supported by two and forty Columns of Marble, with their Architraves, Freeze and Cornice, the Roof plated with Brasses and richly adorned.

A Bridge must be made as broad as the Street which leads to it. The Piers must be equal to one another both in Number and Size, and be one third of the Aperture in Thickness. The Angles, or Heads of the Piers, that lie against the Stream, must project in Length half the Breadth of the Bridge, and be built higher than the Water ever rises. The Heads of the Piers that lie along with the Stream must have the same Projection; but then it will not look amiss to have them less acute, and as it were blunted. From the Heads of the Piers on both Sides, it will be very proper to raise Buttresses for the Support of the Bridge, in Thickness, not less than two thirds of the Pier itself. The Crowns of all the Arches must stand quite clear above the Water. Their Dress may be taken from the Ionick, or rather the Dorick Architrave; and in large Bridges, it must not be less in Breadth than the fifteenth Part of the whole Aperture of the Arch.

To make the Rails, or side Walls of the Bridge the stronger, erect Pedestals at certain Distances by the Square and Plumb-lines, on which, if you please, you may raise Columns to support the Roof or Portico. The height of this side Wall with the Zocle and Cornice must be four Feet. The Space between the Pedestals may be

be filled up with a slight Breast-work. The Crown both of the Pedestals and Breast-wall, may be an upright *Cymatium*, or rather a reversed one, continued the whole length of the Bridge, and the Plinth at the Bottom must answer this *Cymatium*.

The Causey on each Side for Women and Foot-passengers, must be raised a Foot or two higher than the Middle of the Bridge, which is intended chiefly for Beasts and Carriages, and may be paved with Flints. The Height of the Columns, with their Entablature, must be equal to the Breadth of the Bridge.---And he has given us the Draft of a very neat little Bridge of three small Semi-circular Arches, with a Roof supported by thirty Ionick Columns, &c.

In the 6th Chapter of his fourth Book he treats of Wooden Bridges, which is foreign to our Purpose; but I cannot omit some Things he has therein observed concerning Stone Bridges.-----
 “ Make,” says he, in Page 72, “ the Foundations of your Piers in Autumn, when the Water is lowest, having first raised an Inclosure to keep off the Water, which you may do in this Manner: Drive in a double row of Stakes very close and thick set, with their Heads above the top of the Water like a Trench, then put Hurdles within this double Row of Stakes, close to that Side of the Row which is next to the intended Pier, and fill up the Hollow between the two Rows with Rushes and Mud, ramming them together so hard that no Water can possibly get through; then whatever you find within this Inclosure, Water, Mud, Sand and whatever else that is a Hindrance to you, throw them out, and dig till you come to a solid Foundation; or if you find it necessary, make one of Piles burnt at the Ends, and driven in as close together as ever they can flick. And here I have observed that the best Architects used to make a continued Foundation of the whole length of the Bridge, and not only under each Pier; and this they did, not by shutting out the whole River at once by one single Inclosure, but by first making one Part, then another, and so joining the whole together by Degrees; for it would be impossible to withstand and repulse the whole Force of the Water at once: We must, therefore, whilst we are at Work at one Part,

C

leave

leave another Part open for a Passage for the Stream. You may leave these Passages either in the Channel itself, or if you think it more convenient, you may frame Wooden Dams or hanging Channels, by which the superfluous Water may run off; but if you find the Expence of a continued Foundation for the whole Bridge too great, you may only make a separate Foundation for every particular Pier, in the form of a Ship, with one Angle in the Stern, and another in the Head, lying directly even with the current of the Water, that the force of the Water may be broken by the Angle. We are to remember, that the Water is much more dangerous to the Stern, than to the Head of the Pier," &c.

S E C T. III.

Extract from the celebrated ANDREA PALLADIO.

IN his third Book, Chap. 4. Page 138. He lays down the following Rules, and says, --- "Bridges ought to have the self-same Qualifications that we judge necessary in all other Buildings, which are, that they should be commodious, beautiful and lasting; they will be commodious, when they will not be raised above the level of the rest of the Way, or if they are, when they are of easy Ascent and Descent; and likewise, when such a Place is chosen for building them, as shall be most convenient for the whole Province or City.---Bridges will be fine and lasting, if they are made after the Manner and according to the Proportions specified in this Book; but in the Choice of a Situation for erecting them, Care must be taken to fix on such a Place as may give good grounds to expect that the Bridge may be perpetual, and where it may be erected with the least Expence. That Place must be chosen where the River is narrowest, and also the most shallow, and where its Bed or Bottom is even and uniform, and is either of Stone or of Gravel, because Stone or Gravel are excellent Foundations in Water. Moreover, Swallows or Whirlpools, and that Part of the River's Bed which is sandy, or has much soft Clay in it, ought to be avoided;---but in Case the Bed of the River be altogether Gravel or Sand, then the Foundations

Foundations must be made according to the Directions I shall lay down hereafter."

Chapter X. Page 153.--"In Bridges of Stone four Things are principally to be considered, *viz.* The Heads which are made at the Banks; the Piles or Pilasters, which are fixed in the River; the Arches which these Pilasters support, and the Pavement which is made over the Arches.

The Heads of these Bridges should be made as firm and substantial as possible; because, they not only serve to support the Weight of the Arches as other Pilasters do, but they likewise keep the whole Bridge together, and the Arches from cracking or opening: They ought, therefore, to be made where the Banks are the most solid.---The Pilasters, which are to be made in Proportion to the Largeness of the River, should always be even with regard to their Number.---The Foundations of Bridges ought to be made in Autumn, and in Case the Bed of the River be Stone or Gravel-Stone, you have the Foundation without any trouble; but in Case the Bottom be Quick-sand or Gravel, you must dig therein till you come to solid Ground; or if that should prove too laborious or impracticable, you must dig moderately deep in the Sand or Gravel, and then you must thrust in Oak Piles, which will reach the solid or firm Ground, with the Iron by which their Points are to be armed.

To lay the Foundations of the Pilasters, only one Part of the Bed of the River must be enclosed from the Water, and then to build there; that the other Part being left open, the Water may have its free Current, and so go on from Part to Part.

The Pilasters must not be less in Dimensions than the sixth Part of the Breadth of the Arch, nor generally speaking larger than the fourth; they should be made of great Stones, which are to be joined together with Cramps and Bars of Iron fastened with Lead, that they may be all as it were of one Piece; the Fronts of the Pilasters, or that Side which faces the Stream, are ordinarily made Angular, i. e. that they end in a right Angle, and sometimes they are made Semi-circular in order to divide or break the Water, and that those Things which are impetuously brought down the River

when they strike against them, may be shoved from the Pilasters and pass through the middle of the Arch.

The Arches too should be made very strong and substantial, and with great Stones well united together, the better to resist the constant passing of Carriages, or any other Weight that may happen to come over them. Those Arches are the strongest that consist of a Semi-circle, because they intirely rest upon the Pilasters and never press upon each other; but if by Nature of the Situation and Disposition of the Pilasters, a perfect Semi-circle should not be commodious, as rendering the Ascent and Descent difficult, a lesser Section must then be made use of, and such Arches made as rise only the third Part of the Diameter, and in this Case, the Foundation must be made extremely strong upon the Banks, &c.

In his XIth Chapter, Page 155, he begins to treat of particular Bridges, and says, "Abundance of Bridges were erected by the Antients in several Places, but particularly in *Italy*, and on the *Tyber*, whereof some are at this Day intire, and others have some small Remains only left to preserve their Memory."---And in Page 156, he says, "Extraordinary great and most deserving of Admiration, was that Bridge built over the *Danube* in *Transylvania*, and on which were inscribed these Words, "*Providentia Augusti, vere Pontificis, virtus Romana quid non Domet? Subjugor ecce rapidus Danubius,*" i. e. "This is a memorable Monument of the Labour and Assiduity of *Augustus*, the *Roman* Pontiff: What will not *Roman* Valour enterprise?"

But of all the Bridges that I have mentioned, that appears to me to be the most beautiful and the most worthy of Observation (not only for its Strength but the Compartment of it) which was erected at *Ariminum*, a City of the *Flaminian* Tribe, and I believe by *Augustus Cæsar*. It is divided into five Arches, the three middlemost whereof are equal, consisting of 25 Feet in Breadth, and the two next the Banks are less, consisting only of 20 Feet; all these Arches consist of a Semi-circle, and the Depth of their Archivolte is a tenth Part of the light or void of the greater, and an eighth Part of the light of the lesser ones. The Pilasters, as to their Thickness, are a little more than the half of the light of the greater Arches;

Arches; the Angle of the Spurs, which cut the Water is a right Angle. This, as I observed, the Antients followed in building all their Bridges, as being stronger than the acute Angle, and for that Reason, the obtuse Angle is less exposed to be thrown down and destroyed by Trees or any other Matter, that rolls down with the Stream. On the Sides of this Bridge, there are four Ionic Niches, with pitched Pediments over the four Pilasters; there is a Cornice over these Niches, the Length of the whole Bridge = $1\frac{3}{4}$ Foot high, consisting of a Semirect and a Semirevers and *Tuscan* Blocks. The Piers are sunk 7 Feet into the Bed of the River, the Water is six Feet deep, and the Arches spring 6 Feet above the Surface of the Water.

His XIIth Chap. P. 158, is concerning the Bridge of *Vicenza*: "Two Rivers run through *Vicenza*, one whereof is called the *Bacchiglione*, and the other the *Rerone*: This last enters into the first, just without the City, and so loses its Name immediately. There are two antient Bridges built over these Rivers, one of which is demolished; the other is divided into three Arches, the middlemost is 33 Feet broad, the other two are $22\frac{1}{2}$ Feet each. The Pilasters are the 5th Part of the lesser Arches, and the 6th of the greater, and the Arches rise $\frac{1}{3}$ of their Diameter; their Archivolte has $\frac{1}{3}$ of the small, and $\frac{1}{2}$ of the large Arches, which is a common three-faced Architrave; the Piers have a Plinth that projects about a Foot, and a Foot under the springing for the support of the Centres, and from the level of that Course the front of each Pier is hip'd of, and from hence the Architraves spring. The Bridge is 24 Feet from out to out."

Chap. XIV. P. 161. describes a Bridge, of his own Invention. "The River is 180 Feet. In three Arches, the middle Arch 60 Feet, and the side Arches 48 Feet each; the Pilasters 12 Feet thick, and the Points of the Cutwaters (which are a right Angle) extend 12 Feet each beyond the naked of the Bridge; the middle Arch rises 20 Feet, the side ones 16 Feet, with a three-faced Architrave the 17th of the middle, and the 14th of the side Arches. The Piers finish at the Spring with two leaning Figures, over

over which there are two Corinthian Niches with Statues and pitched Pediments. This Bridge is 30 Feet from out to out."

S E C T. IV.

A short Abstract from SCAMMOZZI and SEBASTIAN SERLIO.

SCAMMOZZI has also treated of Stone-bridges, and the laying their Foundations; for which Purpose, he generally approves of piling, as the safest Way where the Ground is soft. He says, he laid two Designs before the Senate of *Venice*, for the *Pont Rialto*, one of three Arches, and the other of one Arch, which he proposed to lay over the great Canal, with Piles of Timber drove into the Ground, then with Net-work of Timber upon them, and Planks of Oak upon the Net-work, on which the Stone-work was to be raised; and there is not the least doubt but he drew and proposed to execute this Plan of the one Arch, but it is generally allowed as the Work of *Michael Angelo*, built by him in 1591. Indeed, it is a most noble Arch; I have now three separate Drawings of it by me, but they had not any Difficulties of Water to encounter with. The Arch is the Segment of a Circle, the Span 98½ Feet. It springs at high Water Mark, and rises 23 Feet, &c. But let us come more to our Purpose.

Scammozzi proposes four different Methods to lay Foundations in deep Water, viz.

1st. To shut up the River in Parts on one Side, and then on the other, by driving a double Row of Piles, and filling in between them with good Chalk, or some close Materials, then to pump out the Water from the inclosed Part, and clear out the Mud; after that, to pile the Foundation to the extent of the intended Pier, and then to begin your Foundation of Stone, upon a Platform of Plank.

2d. Having sounded the Water, and levelled the Bed of the River, to prepare a Grillage of Oak, strong and well pinned, and bound fast together with iron, and kept upon the Surface of the Water by large Hulks or Gabbards, with Cables and other Machines,

chines, having a thick Stratum of large Stones laid on this Frame of Timber, the Stones being well cramped together, and the Joints filled with strong Puzzoli, Terrass, or Cement, and then letting them down gently to the Bed of the River by proper Machines and Cables.

3d. To turn off the River another Way, or to make several Channels to sink the Water, then with a Number of Workmen to make a Dam with Piles, above and below where the Bridge is to stand, quite a-cross the River, and so turn the Stream into the new Channel; then to clear the Earth and Mud away, where the Foundation of the Bridge must be laid, and to build the Piers above the Water, and after that to let the River return into its proper Channel.

4th. He seems to think that the Emperor *Trajan* must needs have made use of the following Method, in building that wonderful Bridge over the *Danube*, viz. To take an Elbow or Bend of the River where it makes a Peninsula, to cut out a direct Canal through the Neck of Ground or Isthmus, then to build the Bridge with ease and upon dry Ground, and afterwards to open the Passage through the Ground left at each end of this new Bed or Channel, whilst the Bridge is building, then turn the River through it, making strong Dams on the old Channel to divert the River from its former Course.

Sebastian Serlio mentions the Proportions of some of the principal Bridges at *Rome*, &c. which I think, we do not now stand in any need of, as our chief Enquiry is after the surest and most practicable Method, of laying a Foundation of about seven and twenty Feet under High-water, in an exceeding rough and rapid River; and as I am certain there is not one of all these which we now have before us, that will answer our Purpose, let us turn our Faces Homewards, and on our Way take a cursory View of some of the Bridges in *France*, and let us resolve to inspect narrowly into the Methods, which we hear, they have practised with great Success, in laying the Foundations of many of their Bridges.

SECT.

S E C T. V.

Brief Accounts of some of the Stone Bridges in France, and their Methods of building them.

THERE are many magnificent Bridges in *France*, both antient and modern, and we shall begin with the *Pont Royal* at *Paris*, which was built in 1685, by *Monf. Mansart*: This Bridge is built over the *Seine*, opposite to the Grand Pavilion of the *Thuilleries*, and was executed according to the Plan ordered by the King. The River in this Place is about 403 Feet English, and the Bridge consists of 4 Piers and 5 Arches; the middle Arch is 77 Feet, the two next 74 Feet each, and the two next the Quays 58 Feet each; the two middle Piers are each 16, and the two other Piers 15 Feet each; the middle Arch is 26 Feet high from the springing, and is elliptical, and so are the rest in Proportion; the Road over it is divided into three Parts, the middle is 32 Feet 6 Inches, and the Foot-ways on each Side are 9 Feet 9 Inches broad, and separated by Stone-posts; the Parapets are 2 Feet thick, and 3 Feet 3 Inches high; the River in this Place is about 7 Feet deep, and the Bridge was erected by Means of Batterdeaux.

The Bridge at *Blois*, was designed by the *Sieur Gabriel*: Breadth of the River 935 Feet English; it has 10 Piers, 2 Abutments and 11 elliptical Arches; the middle Arch is 86 Feet 9 Inches, the two next 80 Feet each, the two next 73 Feet each, the two next 66 Feet each, the two next 60 Feet each, and the two next to the Quays are 55 Feet 4 Inches each: Total Water-way 755 Feet 5 Inches; the two middle Piers are 22 Feet 6 Inches each, the two next are 17 Feet 2 Inches each, and the other six are 16 Feet 1 Inch each: Total solids = 175 Feet 10 Inches, and the two Abutments = 60 Feet; the Piers project 16 Feet beyond the extent of the Bridge on the upper Side, and 10 Feet below the Bridge, and terminate in right Angles; the Height of the middle Arch is 36 Feet 10 Inches, and the rest in Proportion, and all elliptical;
from

From the bottom of the Piers to the spring of the Arches it is 16 Feet 6 Inches; the Breadth of the Bridge is 45 Feet 6 Inches, between the Parapets, which are 2 Feet 2 Inches each; the Carriage-way is 30 Feet, and each of the Foot-ways is 7 Feet 7 Inches, and raised about a Foot above the Carriage-way; the Foundations were laid on Oak Piles, and the Water kept off in the mean Time by Batterdeaux.

There are a vast Number of other very excellent Bridges in *France*, whose Foundations have been laid after the same Methods, on which I shall make some Remarks very soon; but as I am not writing a History of Bridges, I shall desist; my present Purpose being to find out and lay down some effectual Methods to keep off the Water till we should accomplish our Designs, which I shall now begin to prepare for and to consider minutely, not by Way of Precedent, but in order to shew young Students that there are an infinite Number of Matters and Things to be thoroughly examined and digested, before one can sit down to draw a proper Design of this Nature; for in many Cases, a Plan or Design, that may appear curious or elegant enough upon Paper, may prove the Instrument of involving both the Projector, his Employers and the Public in very disagreeable Circumstances, of which there are numerous flagrant Instances to be met with.---But to proceed.

C H A P. III.

A succinct Narrative concerning the re-building of Essex-bridge.

S E C T. I.

On the Plan, Soundings and Borings of the former Bridge.

EXPLANATION of PLATE IV. Scale 30 Feet 1 Inch.

THIS Plate exhibits a Plan of *Essex-bridge*, as it was in 1751, and the Basis of the Effigy, with some of the Borings or Piercings into the Bed of the River, as also the Soundings above
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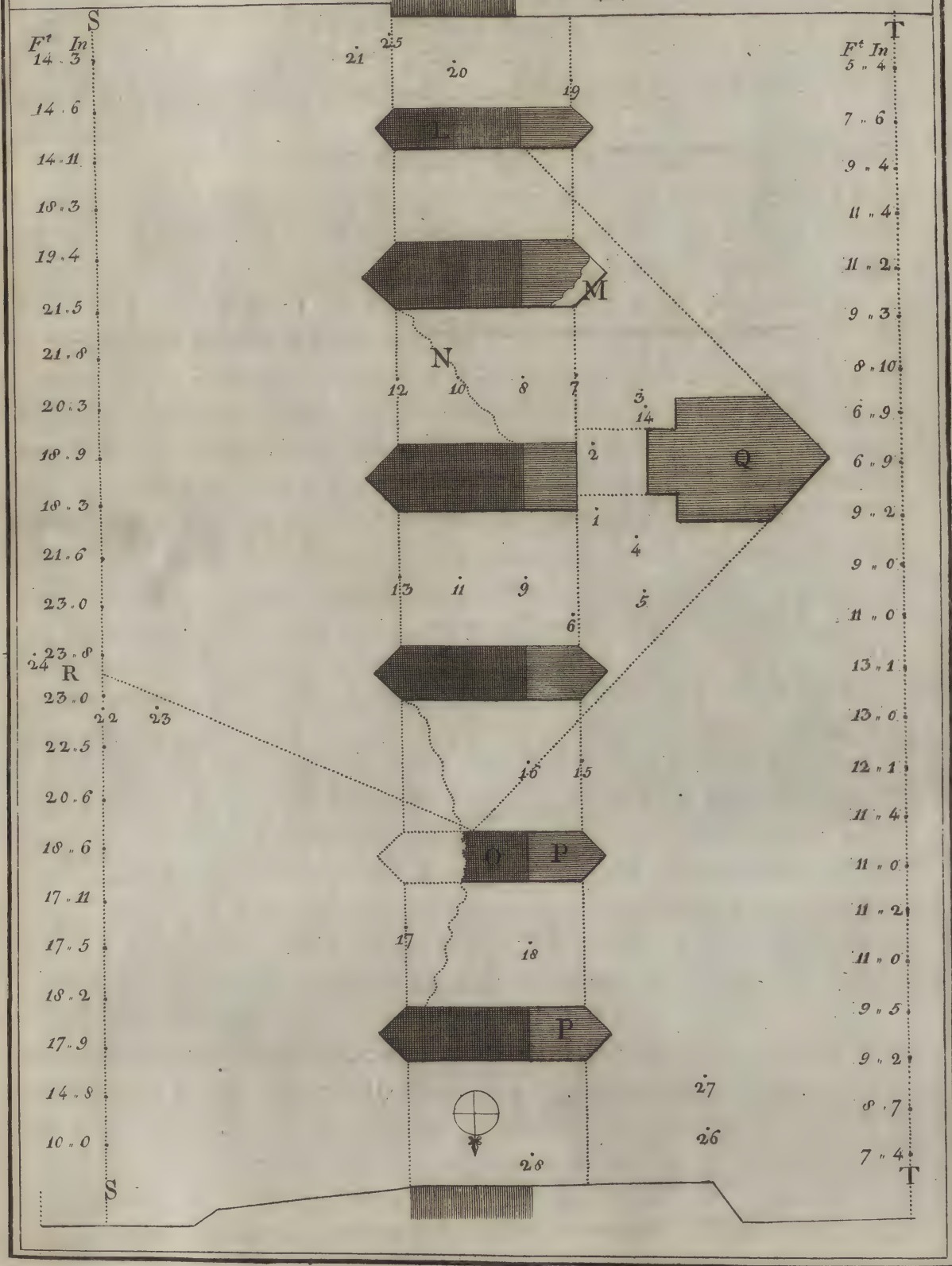
and below it: In explaining of which, I shall demonstrate the Cause of the Failure thereof, wherein note,

L. The Pier that was rebuilt, and now standing on the Ruins of a former Arch, as before-mentioned. M. Part of the Under-work of the second Pier of the Foot-way, failed and carried off by the Floods. N. Shews a Diagonal opening quite across the third Arch, caused by the second Pier having sunk into the Bed of the River Westward, and the third Pier Eastward. O. What now remains of the fifth Pier. P P. The two Piers of the Foot-way that have sunk the most into the Bed of the River. Q. Basis of the Effigy. R. Shews how the Current is now directed by the Basis of the Effigy, the Consequence of which shall be hereafter explained. S S. Shews the Soundings of the River at High-water, taken in a direct Line, 60 Feet below the Bridge, in every 10 Feet. T T. Shews the Soundings of the River in every 10 Feet, taken in a direct Line, 65 Feet above the Bridge.

I took these Soundings in the following Manner: I had a Hawser strained very tight from Quay to Quay, to which we moored our Boat, and over that at a proper Height, we had a tight Rope marked in 10 Feet Divisions, and numbered. I had also a sounding Rod, made of a Piece of Scantling 26 Feet long, 4 by 2 at the lower End, and 2 $\frac{1}{2}$ by 1 $\frac{1}{2}$ Inches at top; the Butt of it was firmly fixed in a Cut-stone of 4 Inches thick, and about 20 Inches Diameter. The Rod was marked out in Feet and Inches painted. In the Butt of the Rod there was a Hole, through which a long Piece of Sash-cord was drawn, by which we hove the Rod along, noting the Depth at every Division, and notwithstanding the Rapidity of the Water, we got this done with tolerable Exactness.

I took the following Method to bore the Bed of the River; the Rods were in three Pieces of Inch Square Bar of just nine Feet each, which screwed together occasionally; into the lower one the Chissell or Augers were screwed, the Chissell or Piercer, was well steeled, with a drill Point; we had a handle like that of an Auger, which moved up or down, and by a Screw made tight whenever we pleased: Practice soon taught us, that we did not know how to perform this trifling Piece of Work in that rapid Water; but we
soon

Pt. 4.





soon found it necessary to bore through wooden Pipes made of 6 Inch Scantling, of different Lengths, with Iron Ferules on the lower End, to drive into the Bed of the River, and an Iron Hoop at the Top, to keep it from splitting in the driving.

I ought to have observed, that I had erected many sounding Boards in the most conspicuous Places; these were made of Inch Plank 12 or 14 Inches broad, divided into Feet and Inches, with very large Figures painted, some upwards and some downwards, from the Low-water mark.

We frequently kept several Pipes drove down at one Time, of different Lengths, to answer the Tide, always observing to note the exact Spot or Scite of each of them in the Plan, and they were all numbered so that we could not mistake, as in each of them we were guided by our sounding Boards: And here I think it necessary to give this caution, if you are boring through sharp or quick Sand, do not let your Rods get any rest, for if you do, the Sand will set upon your Piercer or Augre, and you will hardly get it out again.

This is all I think necessary to be mentioned concerning sounding and boring; but observe, that the large Dots over the No. shew the individual Spots into which we bored: As for instance, at the N. W. corner of the third Pier is No. 1, and the S. W. corner of the same No. 2, &c. N. B. The ordinary neap Tides in Summer generally rise about 6 Feet and a half; but when Land-floods meet with Spring-tides and a S. E. Wind, they often rise to 12 or 13 Feet: However, in our Work, we computed our High-water-mark at ten Feet upon an Average, and we took all the Soundings and Borings from the same.

Remarks on the cause of the Failure of the Bridge.

ALL the Piers were originally built on Frames of Oak, of about 9 or 10 Inches Square, the Clear of which was just the size of the Pier from out to out; the Bottoms were made of 2 Inch Oak-boards dovetailed into the Frame cross-ways, but done in very coarse rough Work; these Frames were laid on the Bed of the River, on which they built the Piers; the increase of the

Rapidity of the Water between the Piers, sunk and carried off that Bed of the River left between the Piers, and continued to sap and gull the Frames every Flood, and the Bas of the Effigy Q. gave a new Direction to the Current, for that on the South Side was directed to the Pier L. where it was obstructed by the Ruins of the former Arch, and as it hurried back to get into the third Arch, it sapped the Foundation of the Foot-way, M. and on the North Side, the Strength of the Current was directed to O. where it did full Execution on that Pier, and then made its Way to R. where meeting again with the Currents that ran through the third and fourth Arches, they struggled together, and so wore away the Bed of the River to 23 Feet 8 Inches deep, and sometimes deeper, just as the Flood and Ebb happened to leave it. Now let us examine the borings of the Bed of the River.

B O R I N G S.

N ^o .	Feet.	Inches.	
1	11	9	To the Bed of the River.
	3	5	Pretty close Gravel.
	3	6	Ditto. softer and finer.
	4	7	Ditto. rather closer.
	23	3	We came to the Rock.
2	11	6	To the Bed.
	11	6	Gravel and Sand.
	23	0	Rock.
3	9	6	To the Bed.
	6	0	Gravel and Sand pretty close.
	6	6	Ditto. but closer and finer.
	22	0	Rock.
4	10	2	To the Bed.
	8	1	Gravel and Sand.
	5	9	Very sharp Sand.
	24	0	Rock.

N ^o .	Feet.	Inches.	
5	10	2	To the Bed.
	8	10	Gravel and Sand.
	5	0	Very close, sharp Sand.
	24	0	Rock.
6	11	0	To the Bed.
	5	6	Coarse, sharp Sand.
	6	6	Close, sharp Sand.
	23	0	Rock.
			<i>Note,</i> Between the 4th and 6th boring, by my giving a very short respite to the Men, the Sand set on the Piercer, which we could not move afterwards, and we were obliged to unscrew the upper Joint, and leave the Piercer and the lower Joint in the Ground.
7	10	9	To the Bed.
	7	9	Rough Gravel.
	3	6	Hard fine Sand.
	22	0	Rock.
8	10	9	To the Bed.
	7	9	Loose rough Gravel.
	3	3	Close and sharp Sand.
	21	9	Rock.
9	13	0	To the Bed.
	4	0	Coarse, loose Sand.
	9	9	Close and sharp Sand.
	26	9	Rock.
10	12	0	To the Bed.
	7	0	Loose, coarse Sand.
	5	0	Close, fine, sharp Sand.
	24	0	Rock.
11	14	0	To the Bed.
	5	0	Loose coarse Sand.
	7	0	Loose quick sharp Sand.
	26	0	Rock.

N ^o .	Feet.	Inches.	
12	11	0	To the Bed.
	5	0	Coarse, loose Sand.
	5	0	Ditto. but finer.
	1	9	Rough and stubborn like Quarry Rubbish.
	22	9	Rock.
13	12	0	To the Bed.
	8	0	Loose, quick and sharp Sand.
	6	0	Rough and stubborn.
	26	0	Rock.
14	11	0	To the Bed.
	4	0	Loose and stony.
	15	0	Here we were forced to desist, it was so stony.
15	11	0	To the Bed.
	0	10	Very stony.
	6	0	Loose, sharp Sand.
	3	11	Closer sharp Sand.
	3	6	Something finer ditto.
	0	6	Like Quarry Rubbish.
	25	9	Rock.
16	11	6	To the Bed.
	12	8	Sharp Sand.
	2	0	Something finer ditto.
	26	2	Rock.
17	11	0	To the Bed.
	3	0	Coarse loose Rubbish.
	8	0	Ditto. and gravelly Sand.
	5	0	Fine soft Sand, that we could almost thrust down the
	0	9	Quarry Rubbish. [Rod into it.
	27	9	Rock.
18	10	0	To the Bed.
	7	0	Soft, loose, gravelly Sand.
	1	0	Ditto. but much stiffer.
	7	0	{ Very soft loose Sand, seemingly mixed with Mud,
			{ but not quite so soft as that of N ^o . 17.
	1	0	Like Quarry Rubbish.
	26	0	Rock.

N ^o .	Feet.	Inches.	
19	9	0	To the Bed. (South end)
	7	6	Coarse Gravel.
	16	6	Rock.
20	9	3	Through the Rubbish.
	7	0	Very coarse and stony ditto.
	16	3	Rock.
21	9	3	To the Bed.
	3	9	Stony Rubbish.
	3	2	Finer Rubbish or Gravel.
	16	2	Rock.
22	24	0	To the Bed. (near R.)
	1	7	Loose Sand, or Mud.
	25	7	Rock.
23	24	6	To the Bed.
	1	3	Loose Sand, or Mud.
	25	9	Rock.
24	24	9	To the Bed.
	0	11	Loose Sand, or Mud.
	25	8	Rock. <i>N. B.</i> These last three Numbers are taken
			in the deepest Part of the Whirl-pool, which
			nearly corroborate with the Soundings at R. which
			is 23 Feet 8 Inches deep.)
25	9	3	To the Bed. (South Arch)
	3	9	Rubbish or Ruins of the former Arch.
	3	3	Loose Gravel.
	16	3	Rock.
26	7	6	To the Bed. (See North Side)
	8	0	Soft Sand.
	2	0	Ditto. but much stiffer.
	7	0	Ditto. stiffer and finer.
	1	6	Very stiff, and fine Sand or Loam.
	26	0	Rock.

N ^o .	Feet.	Inches.	
27	7	0	To the Bed.
	8	4	Loose sandy Loam.
	2	2	Ditto. but much stiffer.
	8	3	Ditto. stiffer and finer.
	25	9	Rock.
28	7	4	To the Bed.
	8	0	Soft Sand, or Loam.
	2	6	Ditto. but pretty stiff.
	7	0	Stiff Sand, or Loam.
	1	6	Ditto. and Quarry Rubbish.
	26	4	Rock.

S E C T. II.

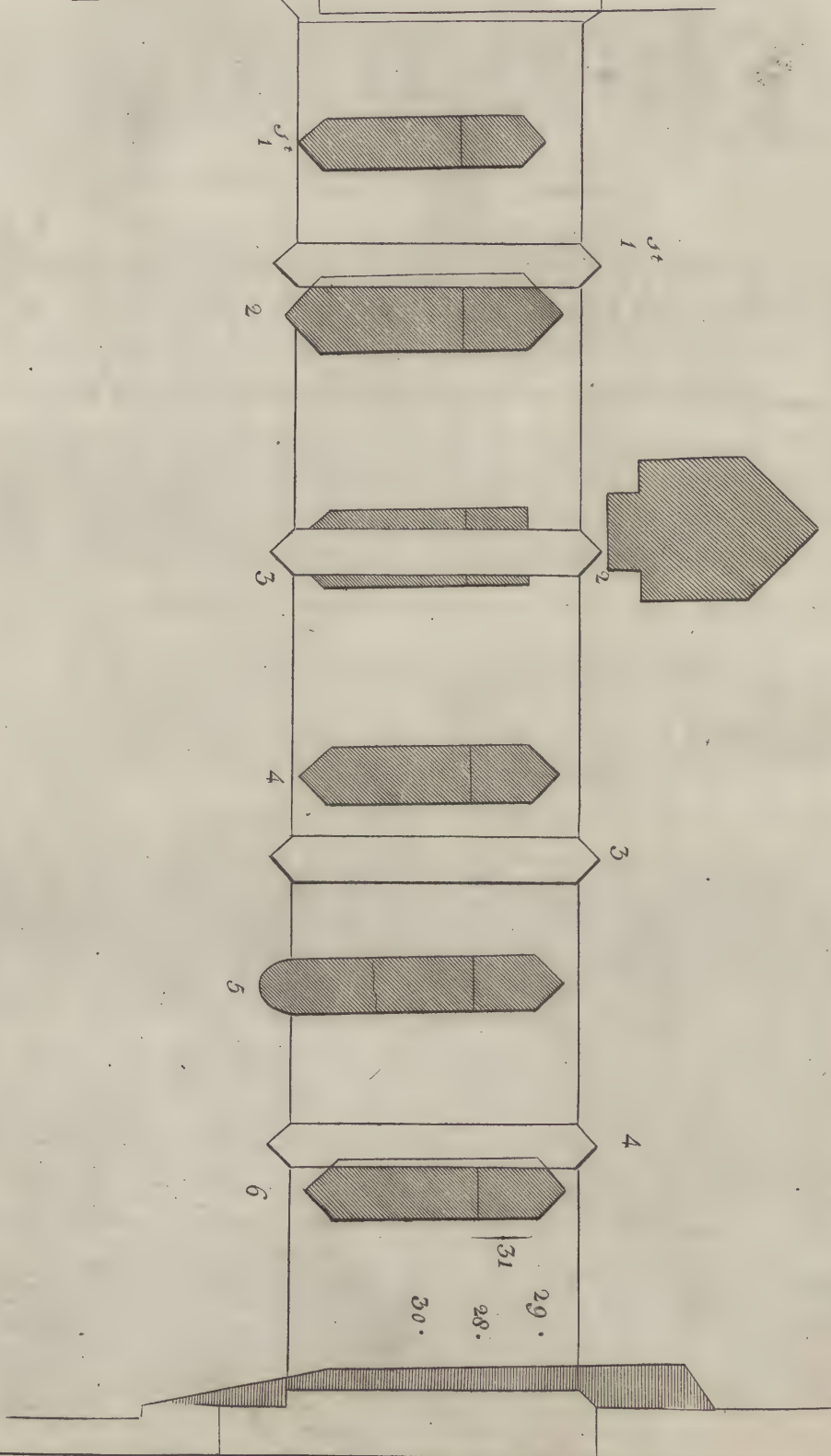
General Remarks on the Bed of the River, &c. and Plans designed for the new Bridge.

FROM these borings it appeared, that the Bed of the River was chiefly composed of coarse Sand, Gravel, Mud, and other loose fluctuating Matters, brought down by the Land-floods, but chiefly since the North-quay-walls were built, and so adding them all together in my own Mind, I found that the Sum total was, that I could not have the least hopes of building a substantial Bridge in that Place, without removing all that loose Substance, and getting down to lay the Foundation on or tolerably near the Rock, which we found quite a-cross the River; but how, or by what Means to get that accomplished in such a rapid River, and particularly in the North Side, where we found the Rock in some Places upwards of 27 Feet under high Water, was the sole Circumstance that quite confounded me, and threatened to frustrate my Intentions of building a Bridge that should last as long as the little adjacent Mountain, called *Sugar-loaf-bill* as I had determined, and made some Declarations to that purpose.

To conquer all these seemingly insurmountable Difficulties, engaged my whole Attention: Many Schemes and Projects crowded, and



Pl. 5.



and some of them made deep Impressions on my Imagination; but whenever the Apprehension of the Danger the Workmen would be in, in Case the Inclosure, I thought I had projected, burst in upon them; they all vanished.

In this distressed Situation I had frequent Recourse to my Books, all of which could not afford me any sort of Encouragement, saving what I have already laid before you: They told me, indeed, to make an Inclosure; and so might they tell a Man, that to measure Time, he must make a Clock; but what would that avail to a Man that had never made nor seen any kind of Machine for that purpose? --- However, I proceeded to form my Plan of the Bridge, in projecting of which, I found myself most plentifully stored with Precedents, and yet after all (in Justice to Mr. *Labeley*) I must declare that *Westminster* Bridge deserved the Preference; therefore (save only in some Particulars) I took it for my Precedent.

EXPLANATION of PLATE V. *Scale 30 Feet 1 Inch.*

THIS Plate represents the Plans of the Old-bridge, and the annexed Design of the New-bridge laid down together; not only to know the exact Parts of the Bed of the River as they then were, but as they were to be occupied by their respective Piers; and likewise to consider and compare them together, with regard to their Voids and Solids.

E

OLD-

OLD BRIDGE. NEW BRIDGE.

	Arches.		Piers.			Arches.		Piers.	
	Ft.	Inch.	Ft.	Inch.		Ft.	Inch.	Ft.	Inch.
1st or South Arch	18	5	0	0	1st or South Arch	36	0	0	0
1st or South Pier	0	0	8	10	1st or South Pier	0	0	8	0
2d Arch - - -	18	5	0	0	2d Arch - - -	41	0	0	0
2d Pier - - -	0	0	12	11	2d Pier - - -	0	0	9	0
3d Arch - - -	27	9 ¹ ₂	0	0	3d Arch - - -	46	0	0	0
3d Pier - - -	0	0	13	0	3d Pier - - -	0	0	9	0
4th Arch - - -	28	1	0	0	4th Arch - - -	41	0	0	0
4th Pier - - -	0	0	9	11	4th Pier - - -	0	0	8	0
5th Arch - - -	26	6	0	0	5th Arch - - -	36	0	0	0
5th Pier - - -	0	0	10	1					
6th Arch - - -	25	5	0	0					
6th Pier - - -	0	0	10	3					
7th Arch - - -	25	10 ¹ ₂	0	0					
Total =	170	6	65	0	Total =	200	0	34	0

By this Scheme it appears that the Water gains 29 Feet 6 Inches in Breadth, more than it had done in the old Bridge.

EXPLANATION of PLATE VI. *Scale 30 Feet 1 Inch.*

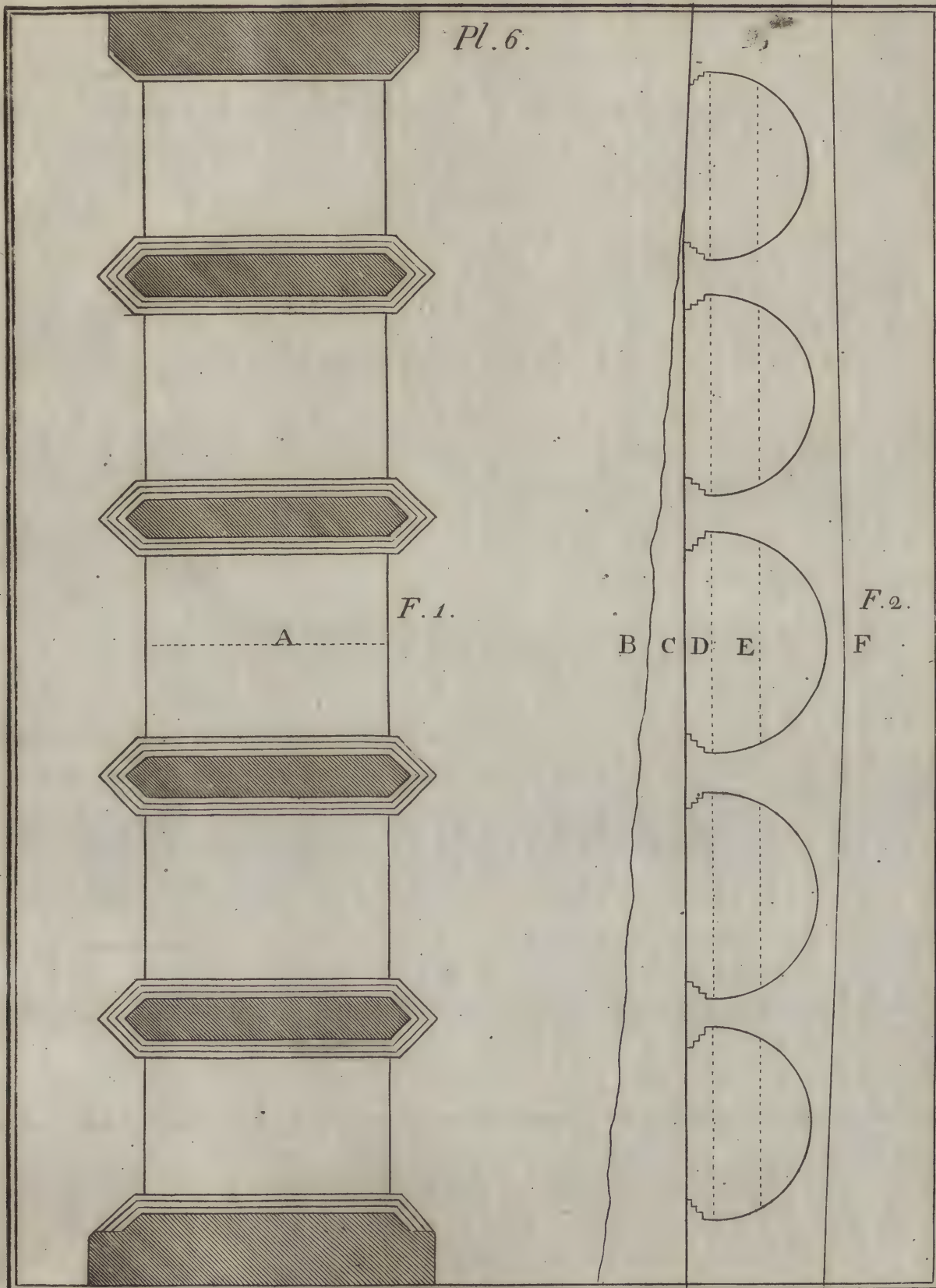
THIS Plate exhibits a Sketch Draft of the new Bridge, wherein note in Fig. 1, A. Breadth of the Body of the Bridge from out to out. In Fig. 2, B. the Rock. C. Surface of the thorough Foundation. D. Low-water Mark. E. High-water Mark. F. Pavement.

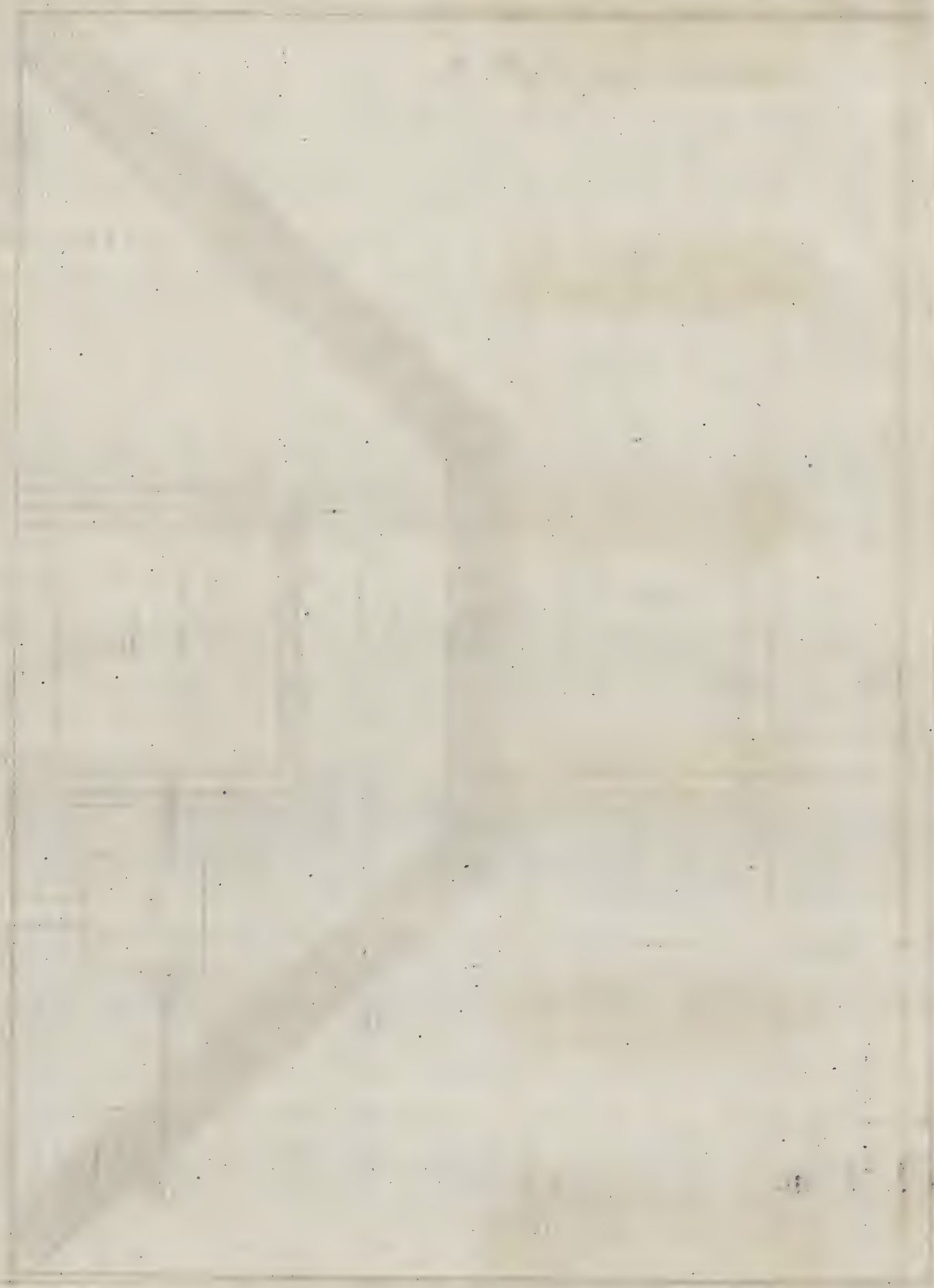
EXPLANATION of PLATE VII. *Scale 40 Feet 1 Inch.*

THIS Plate represents the first general Plan of Operation in laying the Foundations; wherein note, A. the Inclosure, or Cofferdam. B. Pit for North end. C. Pool for the Pumps. D. Water Trunks.

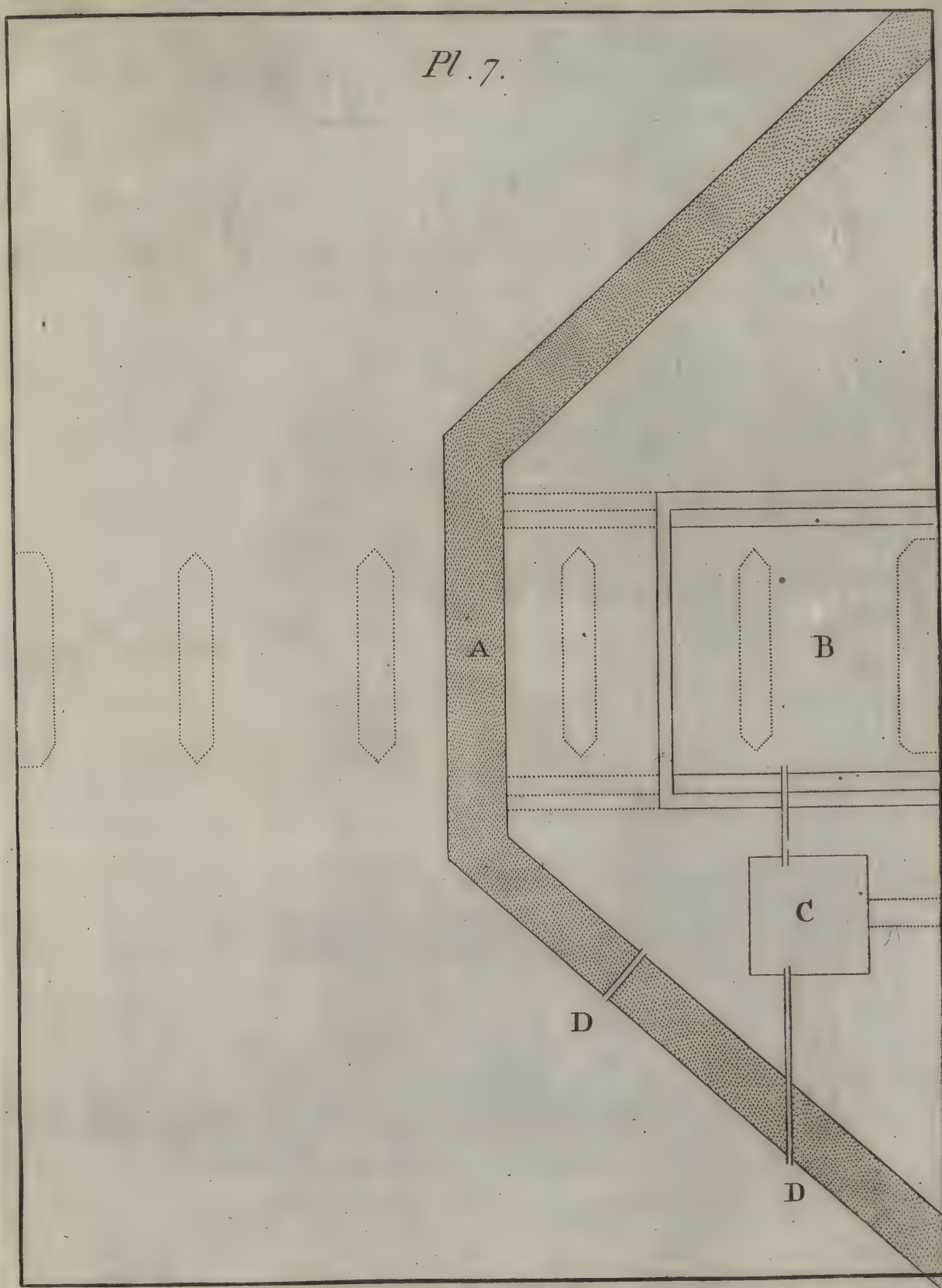
In

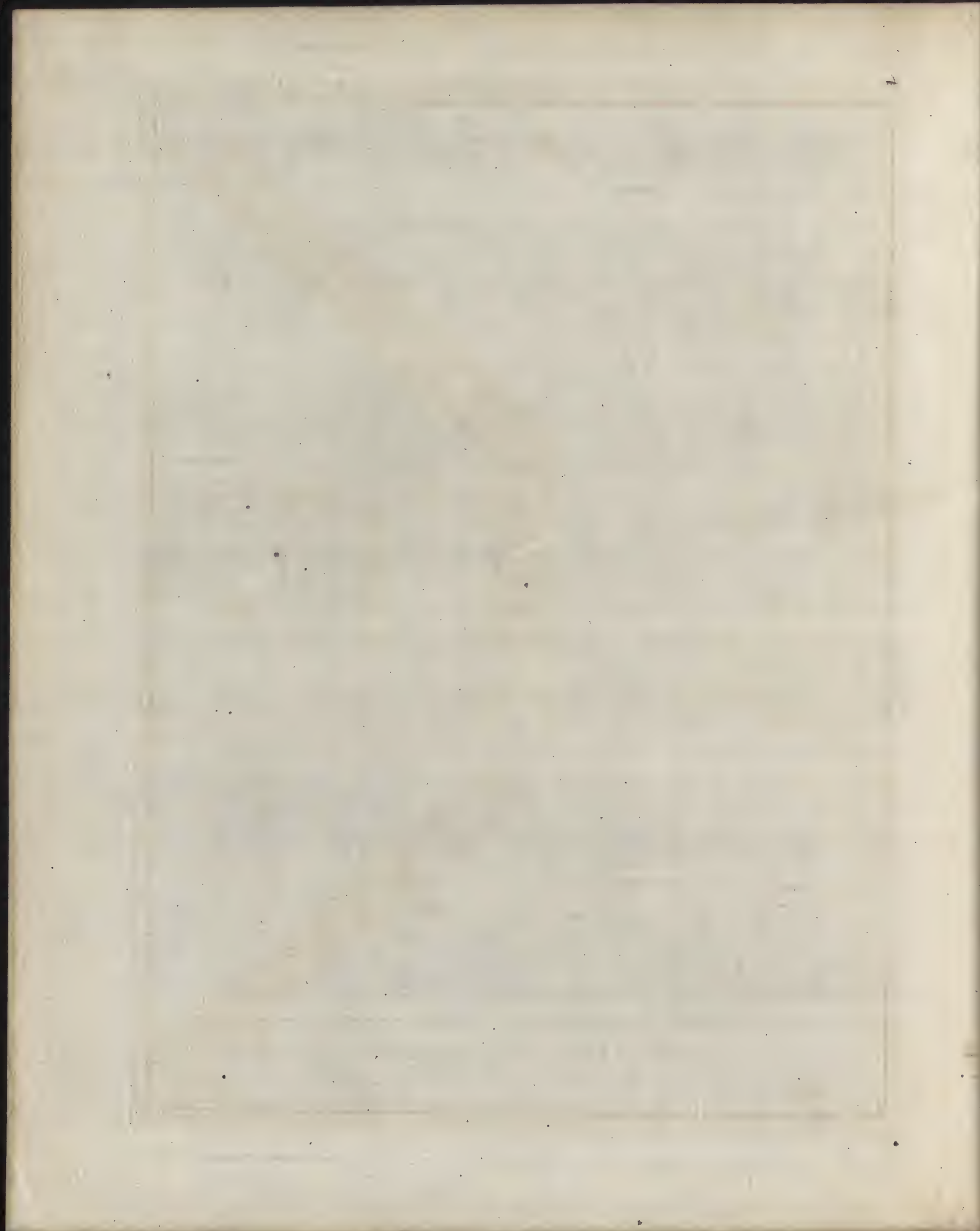
Pl. 6.





Pl. 7.





In my designing this Bridge, I conceived that it was absolutely necessary to depart from one Rule laid down by *L. B. Alberti*, viz. "That the Bridge must be as broad as the Street that leads to it." Now the Street leading to it on the South Side, was but twenty seven Feet broad, including the Projection of the Pallifades, and considering the great increase of the City, I thought that it should not be made less than fifty one Feet from out to out. *Westminster* Bridge, indeed, is but forty-four; but the *Pont Royal* at *Paris* is fifty two Feet broad, and this led me to think of forming a Plan, to get a Street opened in a direct Line of fifty one Feet broad from the Bridge to the Castle, answerable to the Breadth of the Bridge, which would then be conformable to *Alberti's* Rule: And so having got all my Plans adjusted to the utmost of my Ability, on the 20th of May 1752, I set off again for *London*, under these three strong Inducements, 1st. To find out the Methods which were at that Time in Agitation, for opening the Streets in *London* and *Westminster*: 2d, And principally to consult my Friends, and to procure Advice concerning my intended Inclosure for laying the Foundations. And 3dly, to procure several Utenfils, which I knew I should want.

On my arrival in *London*, I soon acquired the Knowledge of their Method of forming Plans, Maps and Schemes, for opening and widening their Streets, and procured the three Acts of Parliament passed there for those salutary Purposes.

But as to my principal Business of procuring Information or Advice, concerning my intended Inclosure for laying the Foundations, I was not so fortunate as to obtain it; for after all my most zealous Endeavours, my Friends gave me no sort of Encouragement, and having laid the Plan, Soundings and Borings before set down, before Mr. *Labely*, he freely told me, that he did not by any Means approve of that Method of laying Foundations in *Coffer-dams*, as he called my Inclosure, and he assured me that it would not answer my Purpose. I then hurried away to my more intimate Friends, Mr. *Etridge* and Mr. *Preston*, who were then carrying on the Pier at *Ramsgate*, as I was extremely desirous of obtaining their Opinions, particularly that of the former, who had been not long be-

fore sent over to project a Bridge for *Coleraine*, and at that Time was employed by some of the Gentlemen of the Corporation of the City, to view our ruinous Bridge, which he did. There was then only a little trifling Fresh in the River; he saw the Rapidity with which it fell; examined and informed himself about the Roughness of the Bed of the River, the Depth of the Water, &c. So I was sure there was no other Gentleman in *England*, that could be so good a Judge of my Coffer-dams, as I shall now call my Enclosure. These two Gentlemen were very courteous and communicative, and told me that as neither of them had seen that Method practised, they could not give me any sort of Encouragement to attempt it; and the former concluded with these Words, 'take Care that you do not find yourself mistaken;' and the latter, with this friendly and parting caution, 'above all Things take Care that you do not spare Timber.'

As I have mentioned *Ramsgate*, I shall only now observe, that that Work was then going on with great Spirit: To me it was really wonderful to see with what Dexterity they handled great Blocks of *Portland* Stone, and with what Ease and Deliberation they laid them under Water. Mr. *Preston* was so kind as to favour me with a rough Copy of their Plan, and I then obtained several, and afterwards collected many other principal Matters relative to it.

Seeing the masterly Proceedings in this great Work, made me look upon my own little Project in a very diminutive Light. However, after staying there two Days, and hearing many Remarks concerning the most commodious Situation for a Harbour in the *Downs*, I posted away to take a cursory view of that Coast as far as *Dover*.

I have mentioned above, that the sight of the Work at *Ramsgate*, had given me some sort of Confidence in the Success of my own Project; but I cannot help relating a very singular Incident that happened on my going down *Dover-hill*, which was so steep that I was obliged to alight and walk down, and my hopes of Success at that Instant operating strongly in my Mind, I chanced to espy a leaf of a School-boy's copy Book lying on the Road, I took it up and thereon found these Words, "*The more positive thou art, the*
more

more wilt thou be derided if thou miscarry." This shrewd, yet just Remark was so *a-propos* to the Situation of my Mind at that Time, that it made a powerful Impression on it; and if it had no other Effect, it at least made me thoughtful and reserved.

I shall not relate the various Opinions of several judicious Persons, whom I consulted concerning my Inclosure, or *Coffer-dam*; but in brief, I purchased more Books in hopes of meeting with something concerning it, as I found I could not acquire any practical Knowledge from professed Artists. I purchased two Chain-pumps, three Double-screws, six Jacks of different Sizes, two Drudging-engines, and several Sorts of Tarrafs, and went to *Leigh* near *Warrington*, to procure some Leigh-lime (which as I was informed, would set under Water as well as Tarrafs) picked up a few Labourers at *Liverpool*, and on the 23d of June returned to *Dublin*.

C H A P. IV. S E C T. I.

Concerning COFFER-DAMS, with a fortunate Incident relative thereto.

ON my return to *Dublin*, I immediately set about to sum up and re-consider all the very little Knowledge I had acquired concerning Coffer-dams; the Result of which was, that after all I found myself in the same Predicament I was before. Not one Man had I seen or heard of, that seemed to be in the least acquainted with the Subject; nor one Book that contained even that Word, or conveyed the least Idea of the Construction of it, except what I before mentioned; but fortunately for me, I went to enquire for some Books at Mr. *George Ewing's*, and telling him of the dubious Situation I was in, he informed me his Son *Alexander*, was then on his Travels, and he believed by that Time in *Paris*. I earnestly requested he would write to him directly in the most pressing Manner, to procure me at any Expence, all the Books, Drafts or Plans, that could afford me any kind of Instructions for laying

laying the Foundation of a Bridge about 25 Feet under High-water, in a rapid River, and to send them with all Expedition.

He most zealously performed his Part, and it happened at that Juncture, Colonel *Belidor*, had compleated his 4th Volume of *Hydraulic Architecture*, which was sent me, together with the other three Volumes; and also a perspective View of the Men at Work in a Coffer-dam, at the Bridge at that Time rebuilding at *Orleans*. --- The Language I was a Stranger to; but on turning over the Plates, I quickly perceived his Construction of Coffer-dams, as we now call our Inclosure. My drooping Spirits then instantly revived, and I immediately went on with my Work with Vigour, and entertained the most sanguine Hopes of Success.

S E C T. II.

Concerning the Construction of Batterdeaux, or Coffer-dams.

WE have already noted the *French* Method of laying Foundations in *Batterdeaux*, which is their technical Term for damming off the Water; and it is the very same of that practised by the *Romans*, as is before slightly mentioned by *Alberti Paladio*, and *Scammozzi*, which is translated Inclosure; and I think there is no doubt, but that the *French* have not only retained, but improved and extended this most useful Method, which probably has never been acquired, at least not much practised in any of these Kingdoms, or otherwise, there probably would have been some mention made of it in some of our Books; but particularly in such as were relative to the building of Bridges, or the like Work in Water. They have indeed, of late translated the Word *Batterdeaux*, and rendered it Coffer-dam, which I presume, is a Word or technical Term not used, nor even so much as known in the *English* Tongue before the Year 1734; about which Time it was introduced in some Propositions concerning *Westminster* Bridge; for if the *English* (who are so justly celebrated for Learning and Ingenuity) had been acquainted with this Word, or with this Method of laying Foundations for Bridges, it is not to be supposed, that

that the Authors of the universal Dictionary of Arts and Sciences, and innumerable other Books, would have intirely over-looked an Art of such public Utility.

It was in the Year 1737, that the Act passed for building a Bridge at *Westminster*, on which many Plans and Schemes were projected; but how to lay effectual Foundations, was the principal Thing that engaged the Attentions of the Commissioners. Mr. *Labely* proposed to lay them in Caissons, but several ingenious Gentlemen most earnestly recommended Coffor-dams: Now please to observe Mr. *Labely*'s Objection to Coffor-dams, taken from his Description of *Westminster* Bridge, Page 41.

Proposition 3d, "Why could not the Foundations of the Piers have been laid by the help of Coffor-dams, such as are called by the *French* Batterdeaux?" To which Mr. *Labely* gives the following answer.

"That if the Inclosure is not strong enough in the inside, it will not be able to support the Pressure of the external Water; but admitting it was strong and staunch, he calculates that the ouzing in of the Water through the Pores and Interstices of the Gravel, loose Clay or Sand, would amount to a Hole of six Inches Square, which, he says, is much under the Truth, and that it would give above 770 Tuns per Hour, which is more than 70 Men could pump out, supposing them to Work always with the same Strength both Night and Day; and more than 150 Men, or 30 Horses could do, working as they commonly do." And proceeds, "All that I shall add to this Article is, that some of the Persons who proposed or espoused this Method of making an Inclosure round the intended Pier with Dove-tailed Piles, and pretended to drain the Water from within, might remember how fruitless was the Attempt, or rather Experiment that was made of it in *Hide-park*, not many Years ago."

Note 1st, "As to his Assertion, that the ouzing would give 770 Tons per Hour." 2d, "That they might remember how fruitless was the Experiment not many Years ago." Pray does not this prove that we are not acquainted with this most excellent Method

of

of Working? And how necessary it is to have it cultivated amongst us, I shall leave you to judge on what follows.

Now it is probable that the Story of *Columbus's* Egg will occur to the Mind of the Reader, when he turns to Plate VIII. where he will see Colonel *Belidor's* Construction of a Cofferdam, so clear and so intelligible, that from the bare Glance of an Eye, any common Journeyman Carpenter might readily comprehend it.

EXPLANATION of PLATE VIII. *Scale 5 Feet 1 Inch.*

Fig. 1, is the Plan of it with the sheeting nailed on the Piles, just ready to receive the Clay; that Fig. 2, represents the Section of the Dam in the middle of the Bridge; A. low, and B. high Water marks, and it is in this Place 17 Feet broad, but that Breadth diminishes to 12 Feet up, and to 14 Feet down the River, as you may observe in the last Plate; and also, that the extreme Ends of it are let into the Quay Walls, so as the Clay of the Dam and the Earth of the Banks might unite together.

The Braces, C. are only to be used occasionally, for all the Stages ought to be kept clear, and in Case any part of the Bed of the River should prove softer than another, and the Dam inclines to one Side more than to the other, drive down the Pile e. into the Bed of the River D. and then by the help of a Rope and a Boat-hook, you may guide the point of the Shoe of the Brace-pile f. into a kind of Mortice, or a Hole made for it in the Pile e. at the Surface of the Bed of the River; and if you find the Pressure is great (which is no Way improbable on some Ground) then you may Spike on the Slob or Plank g. and if you please also Spike it to the Dam at h. and all this you might do on the out Side of the Dam also; in Case the Water was 8 or 10 Feet deep, but it was Experience that taught me the Use of these Braces, and they were very serviceable to us.

I must also observe, that the Piles of Colonel *Belidor's* Cofferdam were drawn upright as these are, and that as I did not understand *French*, and could not conveniently get it translated, I do not know what he wrote upon it; but this I am certain of, that the

Pl. 8.

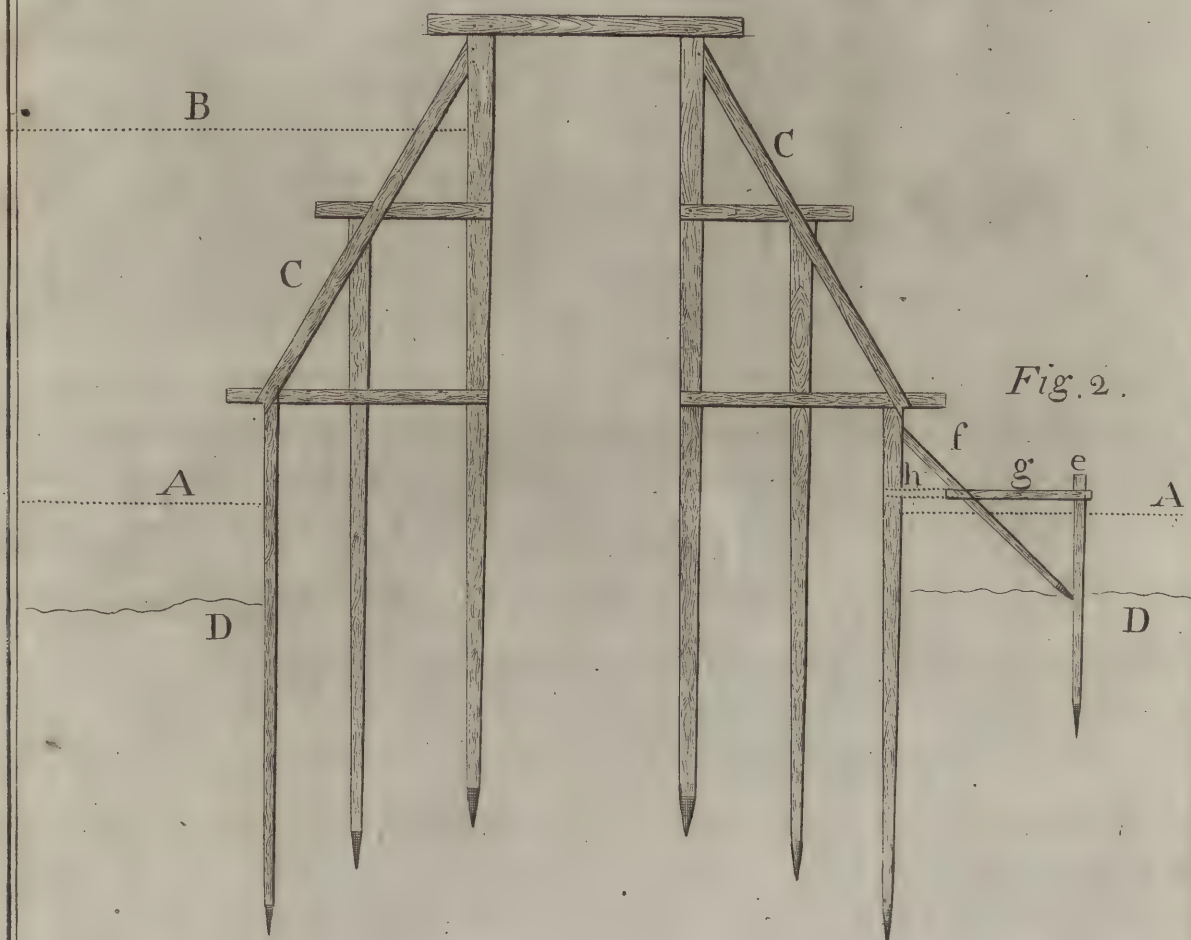
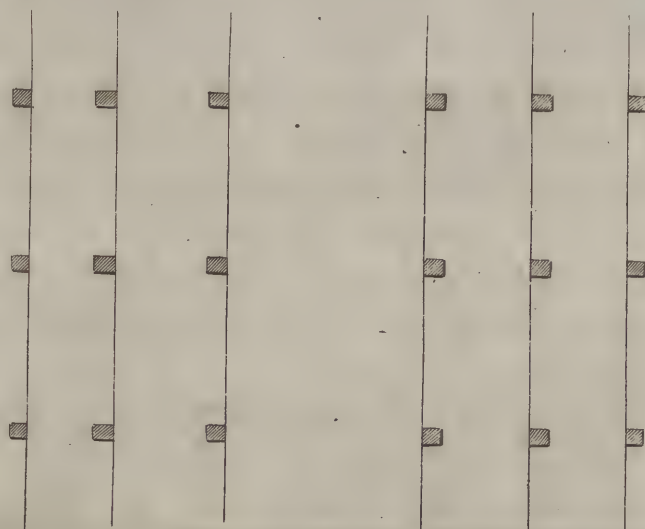
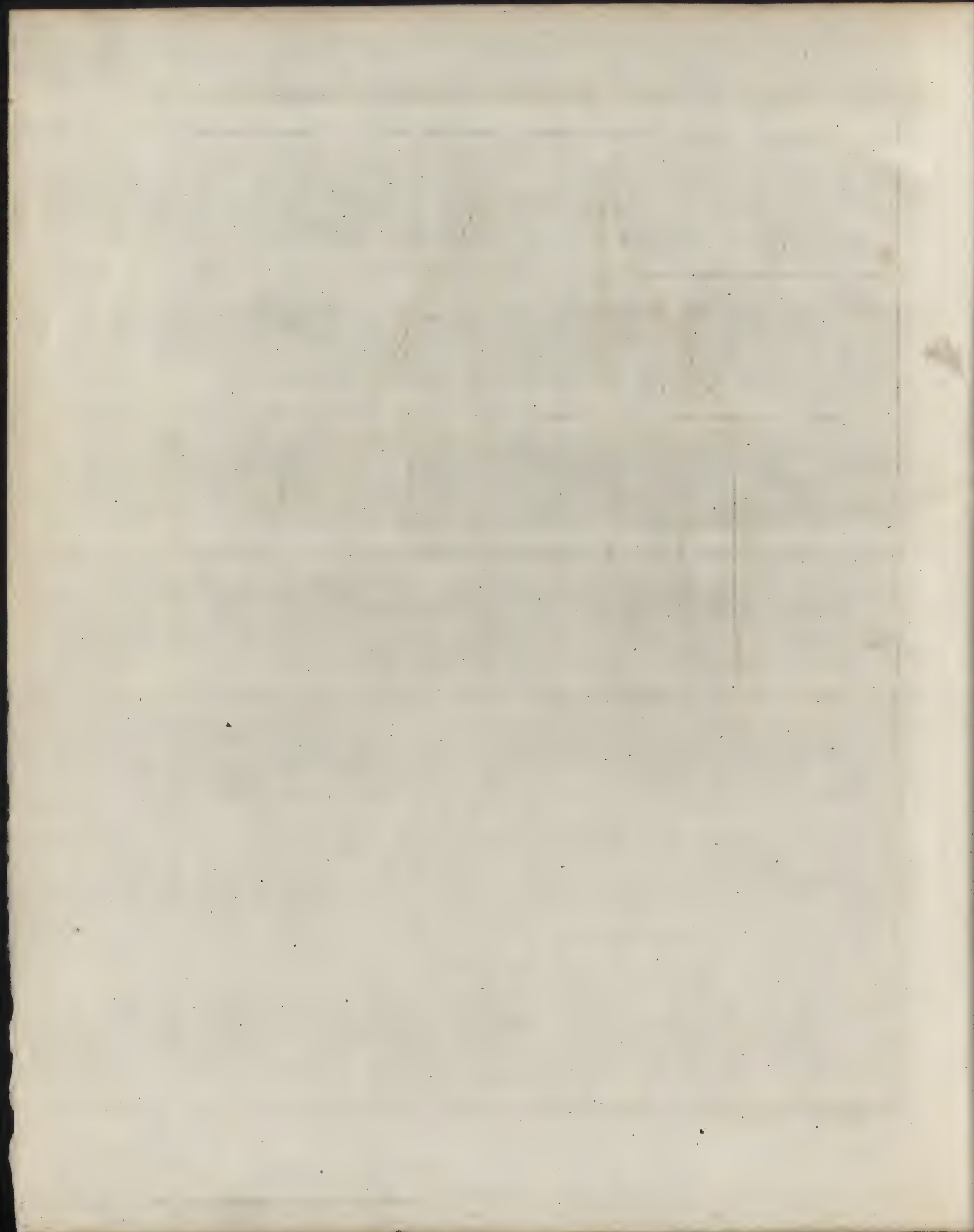


Fig. 1.





the Caps of the middle Rows of Piles, ought to be morticed 9 or 12 Inches narrower, than the Rows are in perpendicular, and in putting them on, to strain the Piles together with a twisted Rope, till they are brought to answer the Mortices of the Caps, and then strain the other outward Rows till they answer the same Batter; for this equal Batter on each Side, makes the whole Dike fit steady and firm on the Bed of the River.

I must now acquaint you with an exceeding great Misfortune which we had to surmount. You have seen both in our Soundings and in our Borings, that within 60 Feet below the Bridge, the Water was about 23 Feet deep, particularly at Boring N^o 24. and that by the Failure of the Pier and in pulling down the remainder of the old Bridge, it was utterly impossible for us to prevent the Water carrying large Stones down the Declivity, and a very great Part of the coarse Rubbish naturally declined into that deep Water; and we found when we were drudging for a clear Seat for our Dam, that it was in a Manner impossible for us to get up much of the Stones and Rubbish: We could, indeed, with our Brakes turn them up, but they tore and totally destroyed our Drudging-bags, and we could not find out any other Way in such deep and rapid Water to get them taken up, and so we were under an absolute Necessity of leaving them there; and upon the top of them we were forced to make that Part of our Dam, and even that was attended with much trouble, because when we were driving our Piles, we often happened on some of the large Stones, that with the stroke of the Ram they frequently tore and burst the Shoes of our Piles to Pieces; but this was not all; as the Bridge was built on the Bed of the River, the Rapidity of the Water between the Piers was continually washing away the Bed of the River, especially at the Stern of the Piers; and in order to prevent that, they had frequently from Time to Time, thrown in large Quantities of rough Stones, to fill up what had been so washed away, and afterwards the great Floods tumbled many of them down the great Declivity of the Bed in that Place, so that there was, as it were, a Wire or a Stone Dike almost quite a-cross the River, about 65 or 70 Feet below the Bridge, which we did not in the least perceive, nor suspect,

when we were boring, as we did not bore any to the Eastward but N^o. 22, 23, and 24. and by their filling up and raising the Bed of the River, they also concluded, that they had thereby taken off the Rapidity of the Water: In short, the force of the Water had carried away every Thing it could, and left little behind it but coarse Rubbish and Stones, which were just like a *French Drain* under our Dike, and the great Wonder is, that we were in any Ways able to conquer it, nor should we have been able to do it but by this one Method. We drudged all we could come at away, as clear as we could from the Back of the Dike, and immediately filled up the Vacancy we so made, by throwing in several Floats of Clay, which united with the Clay of our Dam. If you ever happen in any such distressing Circumstances, I advise you to spare neither Money nor Time, to clear the Seat of your Dam of all such loose Stones and coarse Rubbish, before you begin to make your Dam, and then you will not have the least Trouble nor Anxiety about it afterwards; for of all the Methods that have been invented, I believe there are none so secure, nor so pleasant to execute, as that of building and laying your Foundations on *Terra Firma*: Nor is there any sort of Difficulty in accomplishing it in any reasonable Depth of Water, provided you work on fresh maiden Ground, that has not been fouled or incumbered with Stones.

I must further advise you if ever you have a Bridge to build in pretty deep Water, do not be discouraged by Mr. *Labely's* erroneous Calculation, of 770 Tons per Hour. --- The Circuit or Extremity of our Dam, was much greater than any that he would want for one of his Piers, upon which he made his Calculation; and I affirm that notwithstanding the Roughness and Looseness of our Ground, after we got our Dam staunch as before mentioned, we wrought with great Ease and Pleasure at the North end, which was upwards of twenty one Feet under our high Water mark, and for many whole Tides together, not a single Hoghead of the external Water ever annoyed us; and I am very sure that by the Methods hereafter directed, you may lay a Foundation thirty Feet under high Water mark with great ease, provided as before-men-

tioned, you have clean fresh maiden Ground to work upon in a moderate River.

C H A P. V.

Concerning Pile and Pump Engines.

BEFORE I treat of the Pile Engine, it is necessary to inform you, that in fresh Water Rivers of 5 or 6 Feet or more in Depth of Water, you probably may have very little trouble in making your Dams; recollect how slightly *Alberti* speaks of getting a few Hedge-stakes and the Branches of Trees, &c. to make them, and even in the upper end of our Dam, neither the Trouble nor the Expence was of any great Value, which we performed after this Manner. We floored one end of a small Float, and on that set two Tressels of about 4 Feet high, and in driving the middle Rows, we erected another Stage of the same Height over the first, and drove them with double-handled Mauls, and probably it will not be necessary to shoe them with Iron, but just point them or burn the Points of them in a Fire to harden them, observing to begin at the Head of your Dam, and drive the out-side or in-side Piles just as the Tide answers, and always take Care to keep your Float tightly moored up to your Work, for which purpose it may be necessary to have a Sea-faring Man to help you: Let your Mauls be well hooped and strapped with Iron, otherwise the Hoops may be liable to come off with the driving: According as you drive in your Piles (if the Water be rapid) it may be very proper to nail Pieces of Slabs or the like, to keep them together, lest the Current should displace them; and after this Manner you may do very effectual Work without an Engine. However, I shall give a Draft of ours, which I took partly from *Vaulou's*, and partly from *Belidor's* Designs, as follows.

EXPLANATION of PLATE IX. *Scale 4 Feet 1 Inch.*

This Plate shews the framing of the Platform of the *Pile-engine* in Fig. 1, where in the dotted Lines *a.* shew, that after it is floored, there must be Ledges nailed on to give firm hold to the Feet of the Men that work it; *b.* is the Block into which a Brass Socket is to be fixed for the Axes to stand upon, and this Block must be slid over to *c.* which you will find further described in the 11th Plate; *d.* is the Ladder to bring you to the second Floor, *viz.* Fig. 2, in which note that *e.* is another Block to be framed in its Place with a Collar of Brass, left open quite through the Block, over which there must be a Shutter or Lid to keep it free from Dirt, or to grease it when necessary.

EXPLANATION of PLATE X. *Fig. 1. same Scale as Plate IX.*

This represents the Front of the Engine, with the Ram and Follower resting on the Head of the Pile. Fig. 2. is the Follower playing in its Grooves by a Scale of 1 Inch = 1 Foot. Fig. 3. (by the same Scale) shews the Section of the Follower and Ram, seemingly just ready to engage one another, as also, how the Tongs are opened by the two inclined Planes, *a. a.*

EXPLANATION of PLATE XI. *Fig. 1. Scale 4 Feet 1 Inch.*

Represents the Section of the Engine from Front to Rear, wherein note, that the Block *b.* above-mentioned, is occasionally to slide over to *c.* and one half of the Block *a.* must be firmly bolted down to the Floor, and the other half opens and shuts with a Hinge about the Axes, with Semi-brass Collars, observing to leave proper Room above your Drum-head, for the Axes to lift so high as to clear the Socket of the Block *b.* at any Time, when you have occasion to repair it; *d.* is the Spring that locks the Drum to the Shaft.

Pl. 9.

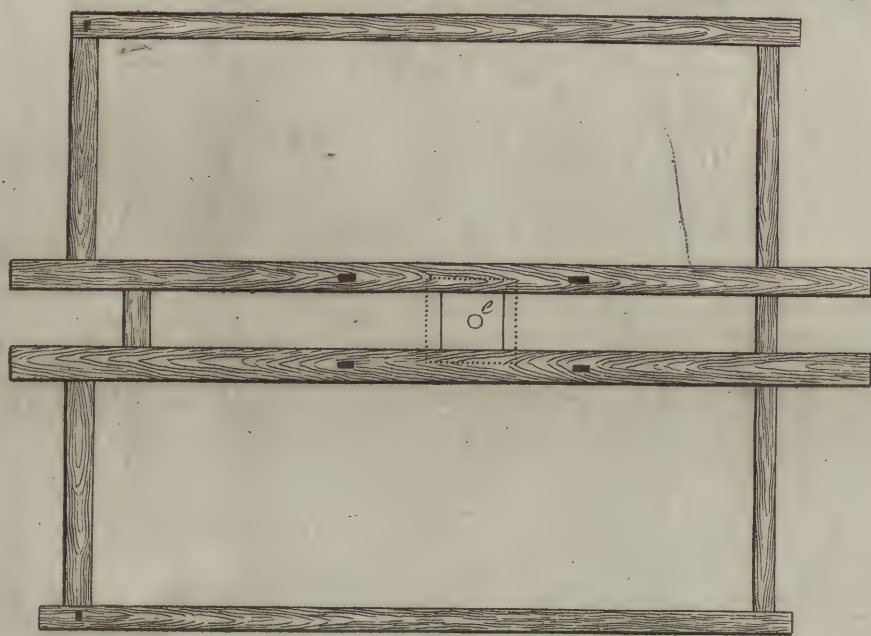
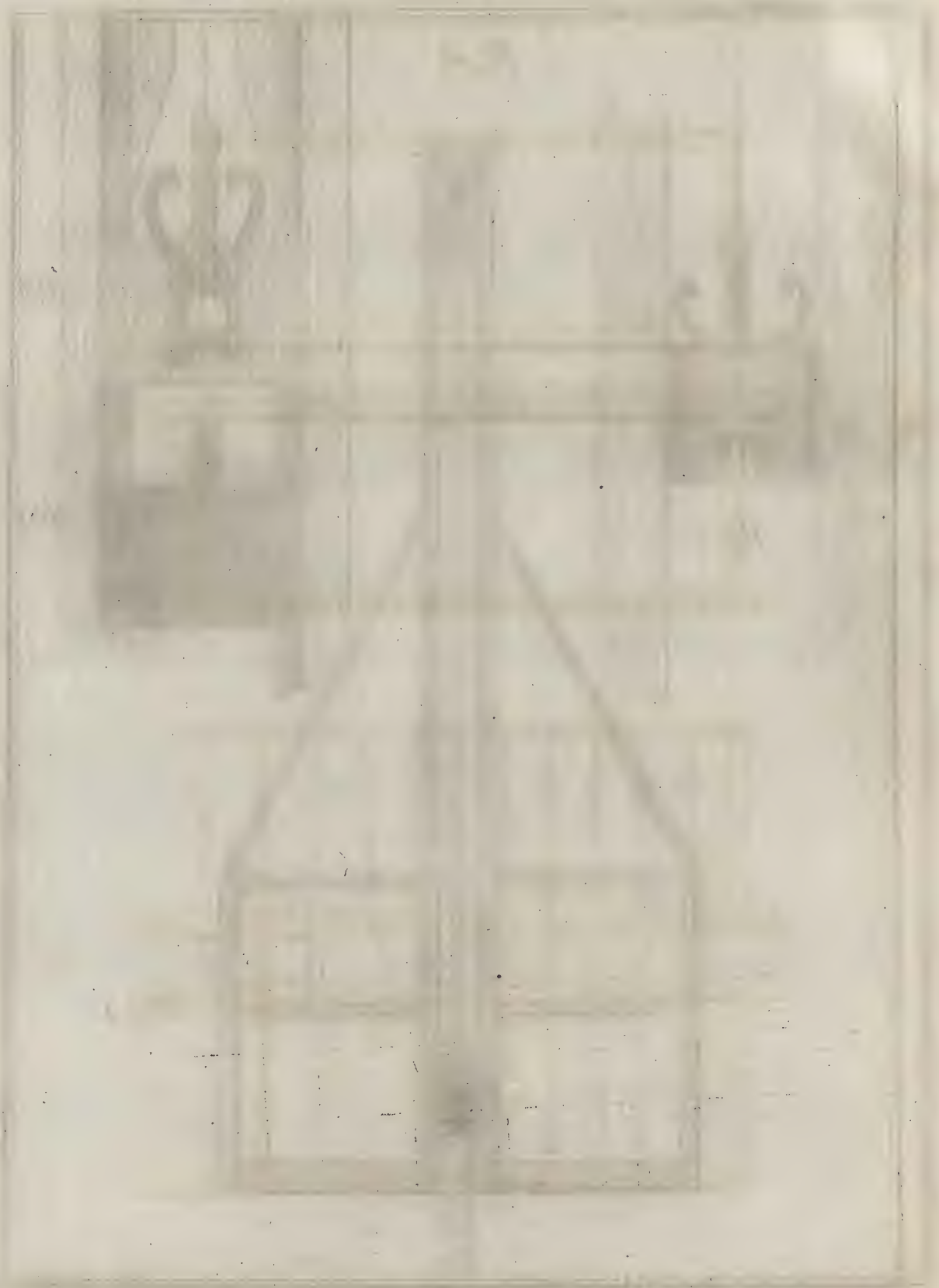


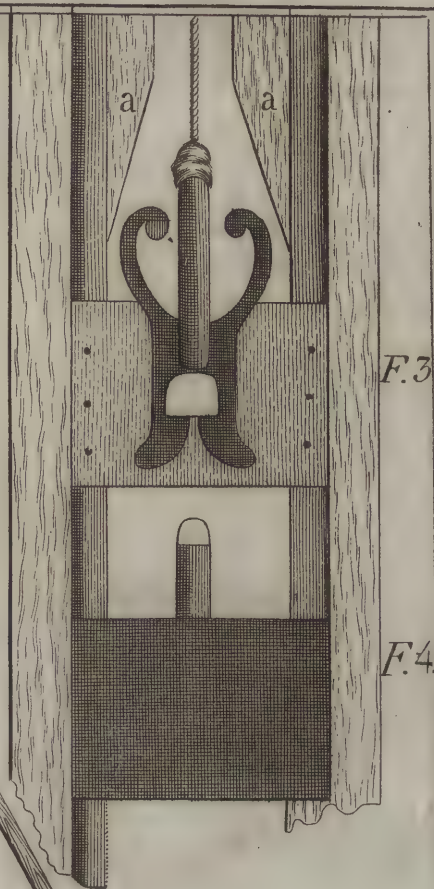
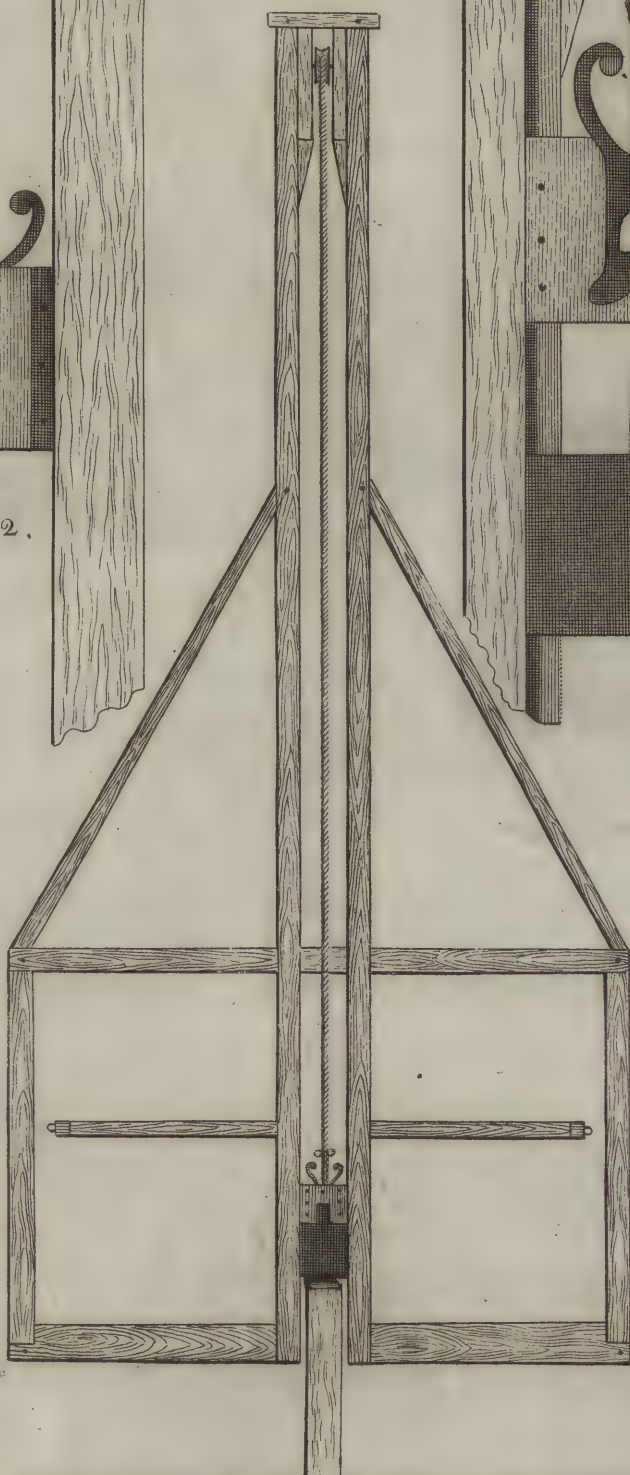
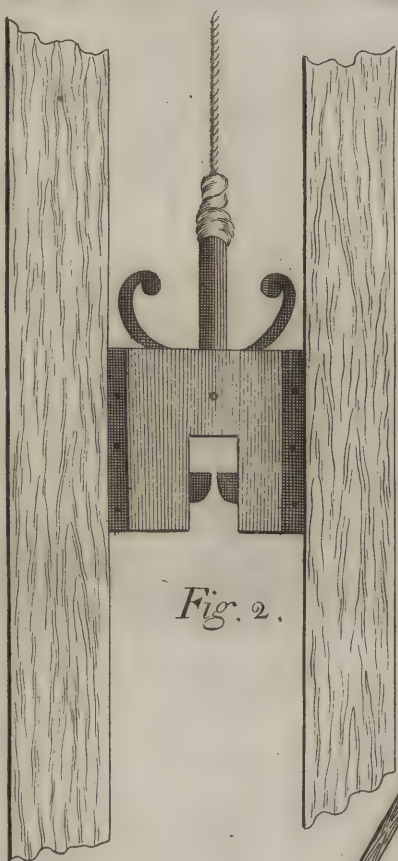
Fig. 2.

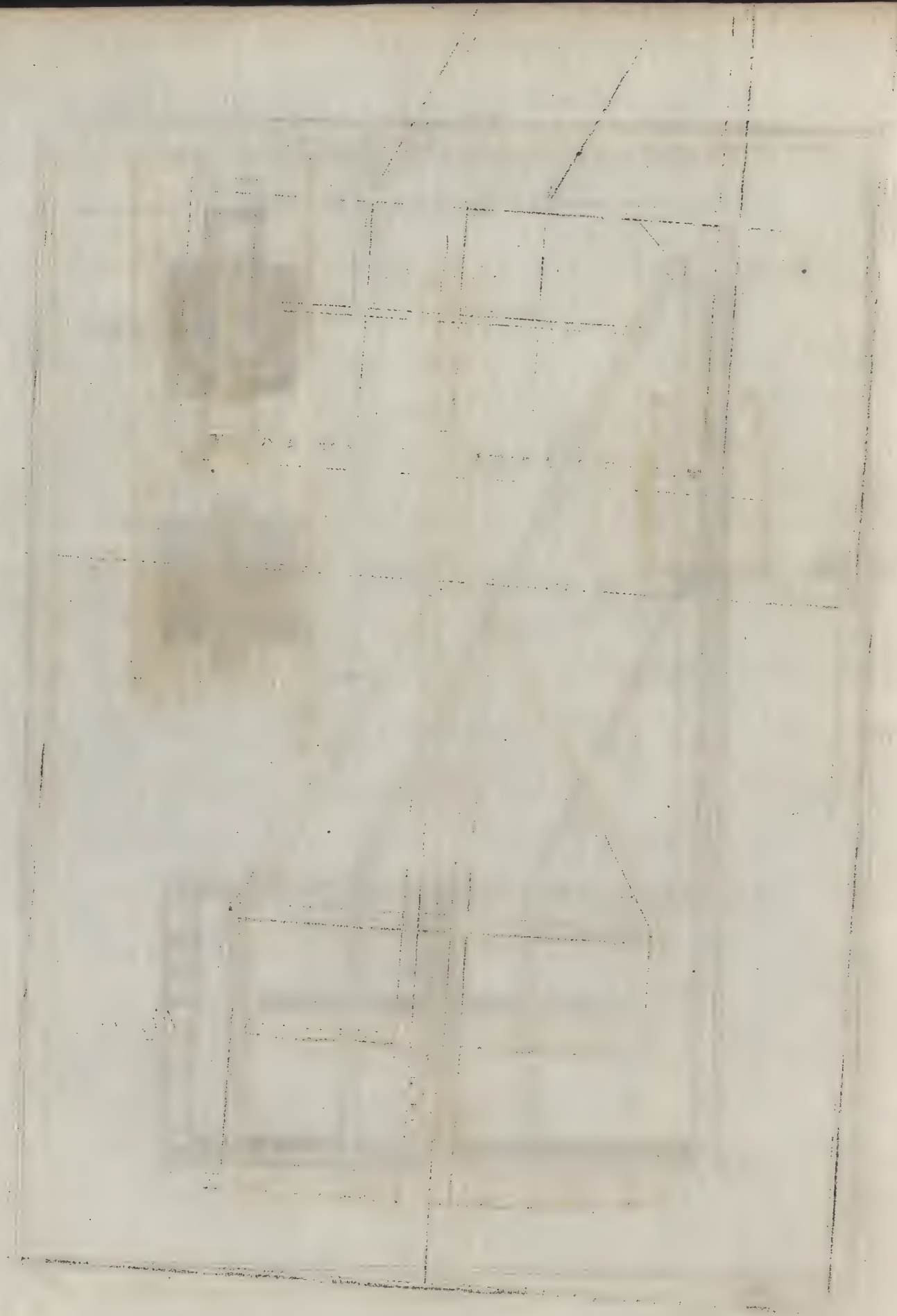


Fig. 1.

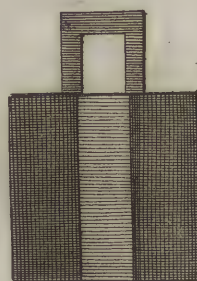
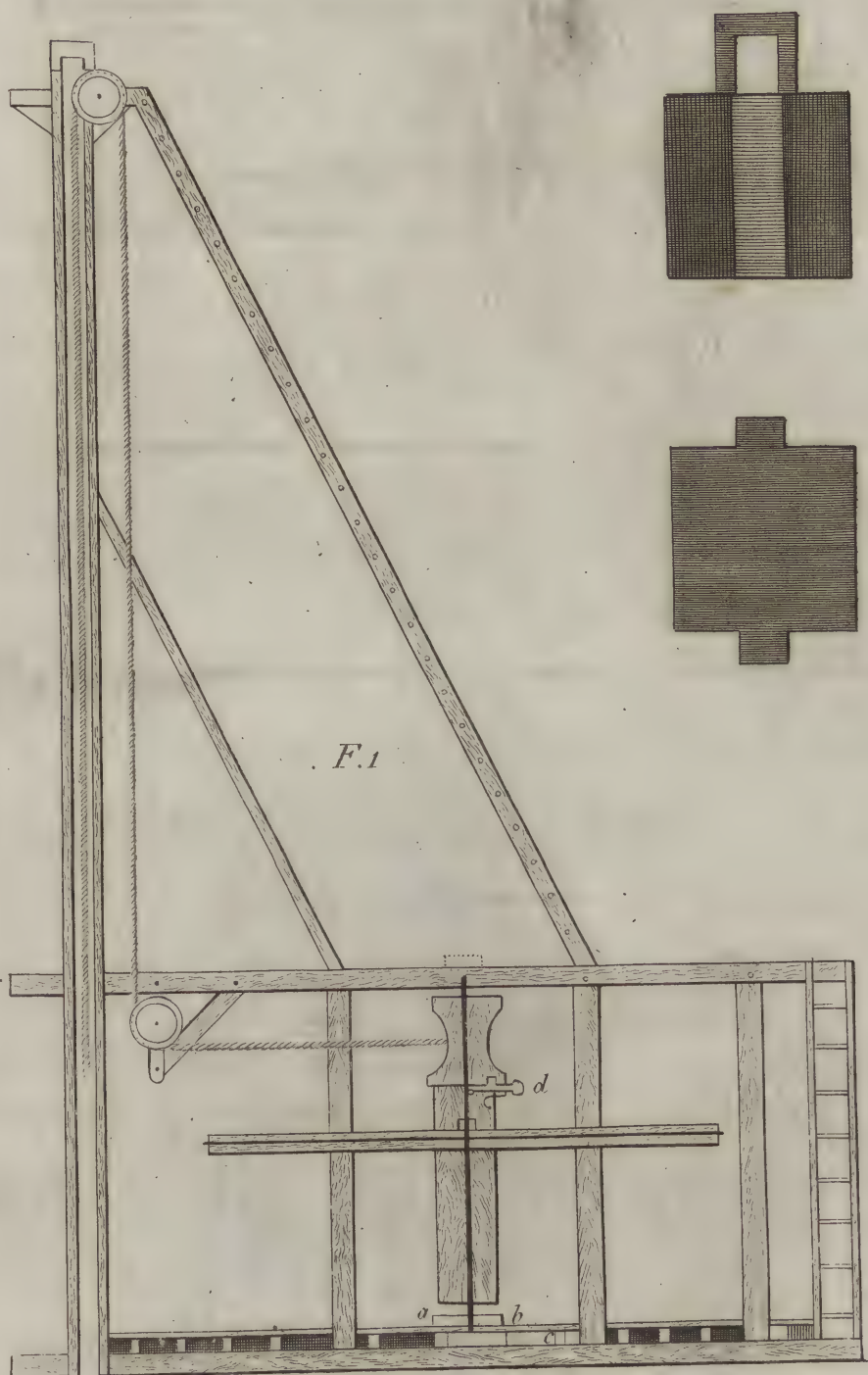


Pl. 10.

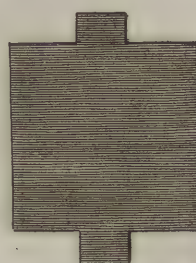




P. 11.



F.3.



F.2.



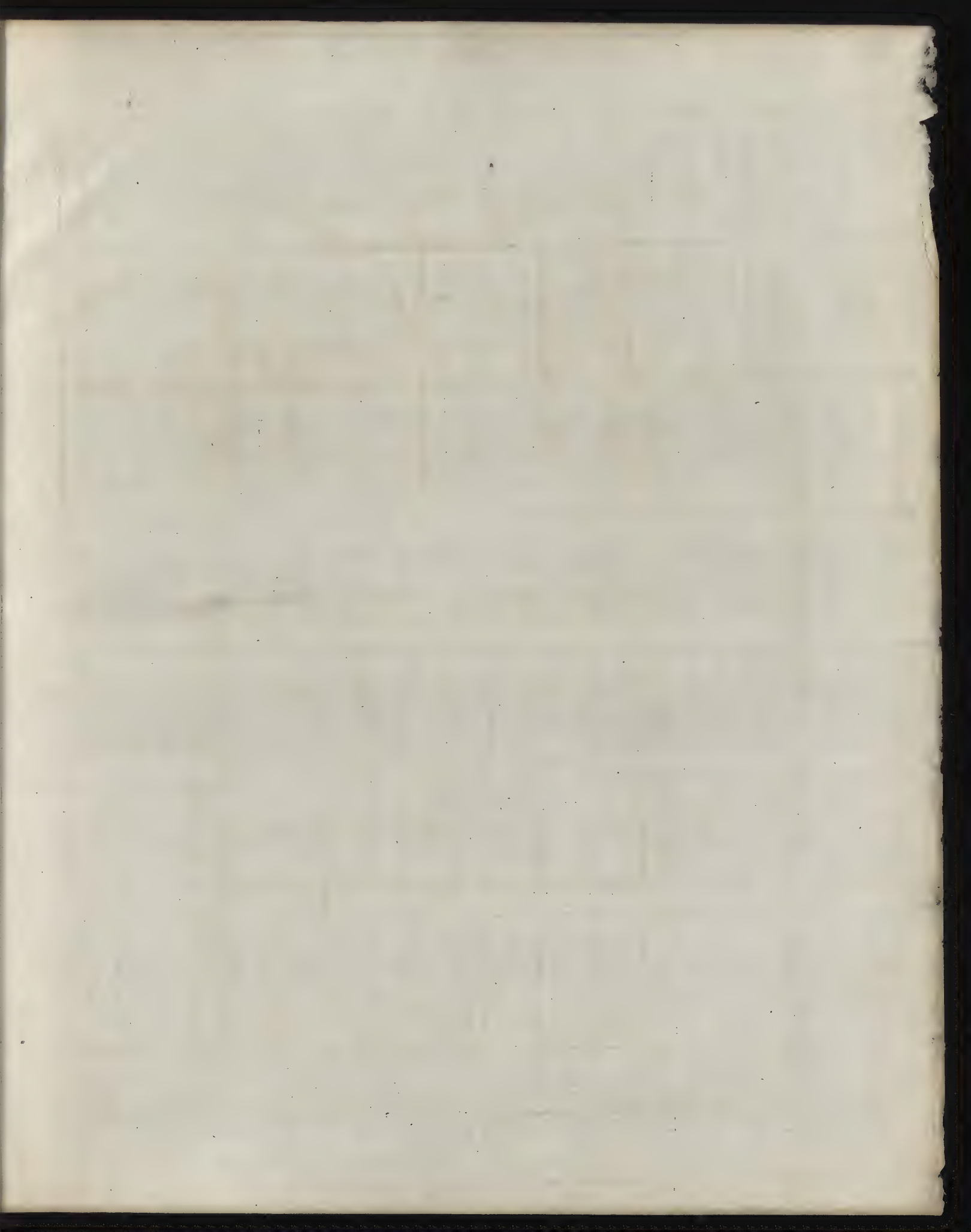


Fig. 2.

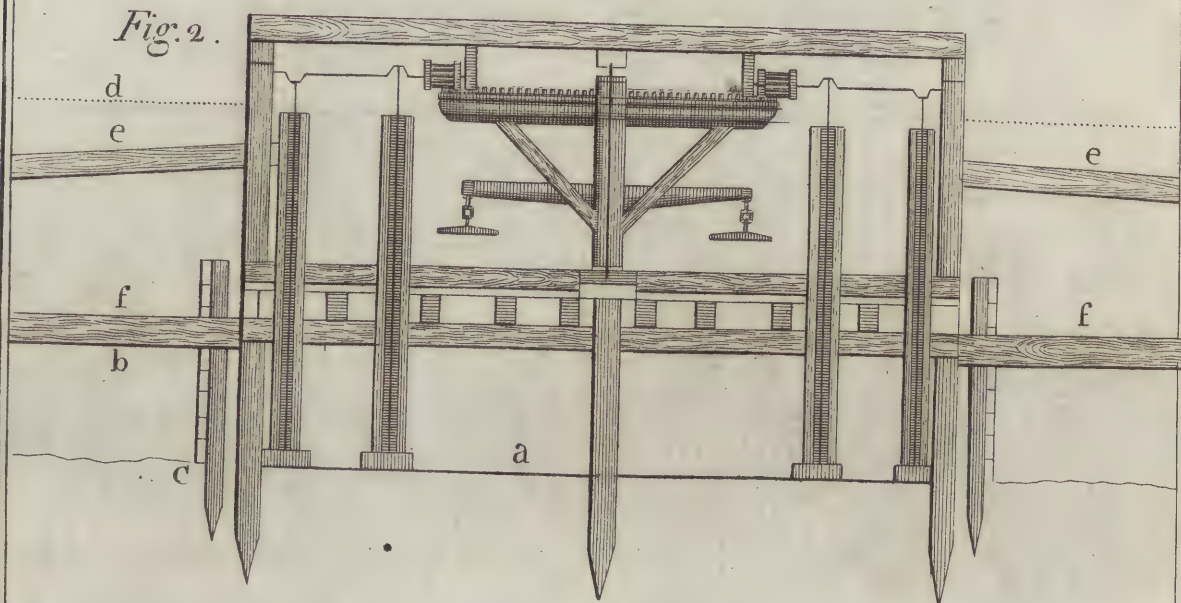
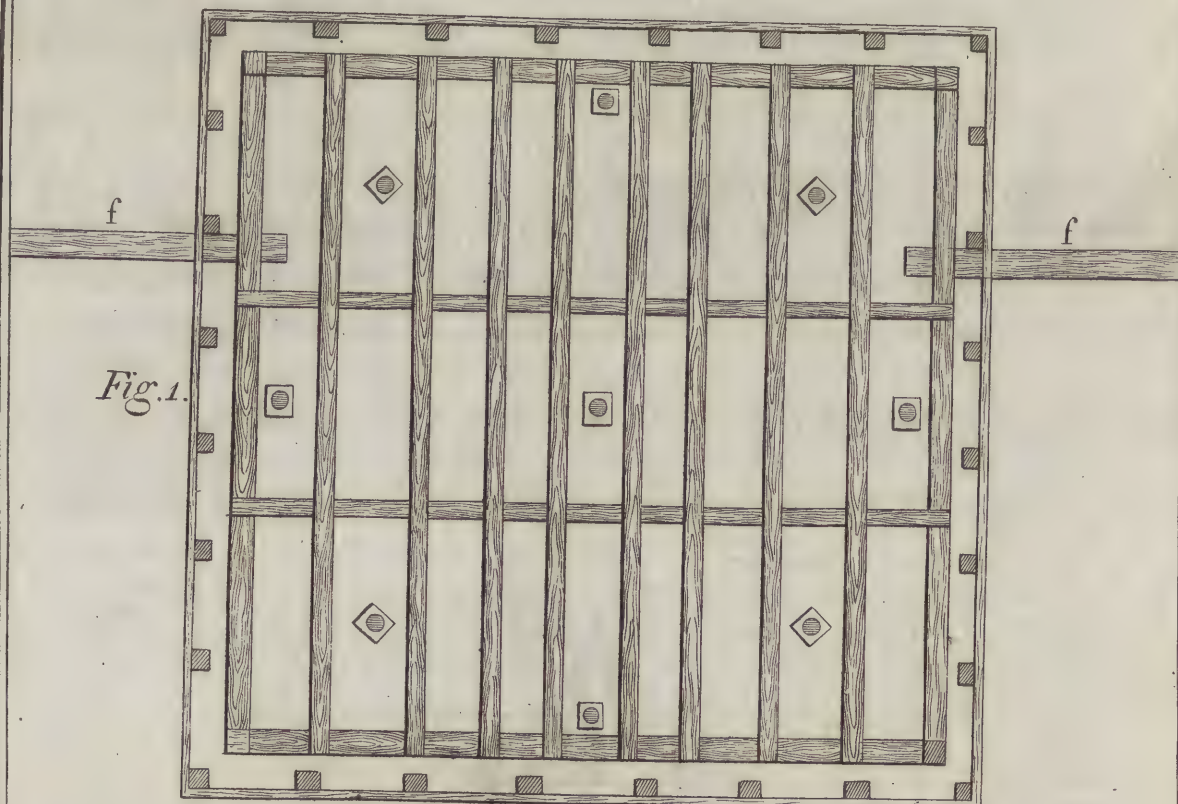


Fig. 1.



Shaft. Fig. 2. (by an Inch to a Foot) is the Plan of the Ram; and Fig. 3. is the Upright of it with the Staple, that the Tongs take hold of. This Ram is only four hundred and a half, which may be fully sufficient for these or the like ordinary Occasions; and for more weighty Work, you may on the same Principles proportion the Size of the Ram to the Size of the Engine which you think you will want.

EXPLANATION of PLATE XII. *Scale 8 Feet 1 Inch.*

Fig. 1. is the Plan of the Timber of the Floor of the *Pump-Engine*, with the Situation of the 8 Pumps, and Centre or Socket of Brass, on which the main Body plays.

Fig. 2. Section of the Engine, wherein note, that a. is the bottom of the Pool; b. Low-water Mark; c. is the Inclosure of Piles and Boards that keep up the Banks of the Pool; d. High-water Mark; e. open Gutters, that convey the Water from the Pumps over the Dike; f. both in Fig. 1. and Fig. 2. and D. in Plate VII. are the Trunks that either carry off the interior, or let in the exterior Water occasionally at Low-water Mark, to which there were Sluices fixed in the middle Stage of the Dike, that were wound up and down by a Jack.

From my first forming an Idea of the Inclosure, my Mind was constantly oppressed with the dread of its bursting in upon the Men, when they were at Work in the Pit as before-mentioned; from which intolerable Anxiety, I was relieved by contriving these Trunks. I cannot tell whether Colonel *Belidor* used any such Thing, because as I before observed, I was ignorant of the Language he wrote in; but I am well assured, and you will hereafter find, that they were of infinite Service to us. The other Parts of this Engine are obvious, as indeed, there is scarcely any good Millwright but what may comprehend and execute the whole Construction of it.

Having now to the utmost of my Power fully considered every Thing relative to this Work, I sat down, and by the Assistance of my Brother *John*, made an Estimate of the Expence, supposing the
Ballus-

Ballustrade to be made of Fire-stone; and we found it amounted to twenty thousand Pounds, and I promised that I would not exceed twenty thousand five hundred, for we allowed the five hundred for Incidents; and I computed, that within, or about the Space of two Years, from the Day upon which I should stop up the old Bridge, that a safe new Road might be made over the new Bridge for Carriages; and upon these Calculations and on mature Deliberation, I made the following Declaration, not only to the Overseers with whom I treated, but also, promised to the Lords Justices, to the Committee of the House of Commons, and to the Public in several Papers to this Effect. 1st. That I would build them a Bridge that should stand as long as a little adjacent Mountain called *Sugar-loaf-hill*. 2d. That the Expence should not exceed 20500 *l*. 3d. That I would have a Road opened for Carriages over it, within or about two Years from the Day of my stopping up the old Bridge as above-mentioned; but I did not any otherways bind myself to the Performance of any of those three Articles, yet notwithstanding, I looked on myself to be as much bound to the Performance of them, as though I had engaged for them under my Hand and Seal, and staked any little Reputation I had acquired, faithfully and effectually to perform them to the utmost of my Power.

C H A P. VI. S E C T. I.

Of demolishing the old Bridge.

WE began on January 19th, 1753, to stop up and demolish the Bridge, and take down the Equestrian Statue of King George I. which had been put up in 1722.

February 19th, we drove the first Pile of the Cofferdam.

In pulling down the Bridge, we began at the South, and took in the largest half of it in order to open and deepen that Side, to let the whole Current run there. In doing of this, I found it necessary to make a temporary Dam; to turn the River to the North, in order to lengthen the Time of Ebb, and clear away the old Ruins, &c.

After

After this Dam was made, we were going on very successfully till the 28th of April, when there came down a pretty strong Land-flood, which obliged me to take the Men off that Part of the Work. I then stood on the northerly Part of the Bridge, dreading the Fate of our poor little Dam, when I espied the Water within Side of it grow very black, the cause of which I well knew to be the blue Clay bursting out, and I hurried down to it in order to see if there was any Possibility to save it; but the very Moment I had got on the top of it, I found the whole rise up under me, and had not above a second of Time to save my Life; for the Floor that was on the top of it turned immediately down, and the Points of the Piles rose up, and notwithstanding the Activity of the Men, great Part of it was carried down the River; but this fright was of much use to me, for as the cause was the Floods getting in under the Clay, I was ever after on my guard by making our great Dam in such a Manner, as might resist the Force of any Land-flood or Torrent.

May 31, the last of the Piles of the Cofferdam was drove, and June 4th, we began to fill the Clay into it, and the same Day having taken up all we could of the Foundations, we began to deepen it by drudging.

S E C T. II.

Description of the Foundations.

THE Foundations of this Bridge, or rather the Piers of it as before mentioned, were built after this Manner. They made Frames of Oak of 9 or 10 Inches Scantling, the exact Shape of the Pier, with rough two Inch Planks of Oak Dove-tailed across it, in every three or four Feet and pinned to the Frame, and on these Planks they stretched other Planks Length-ways but not so thick. These Frames so made, they dragged to their Birth, and let them rest upon the natural Surface of the Bed of the River. The Piers being extremely gross, increased the Rapidity of the Water between them, and the Bed of the River (as you have already

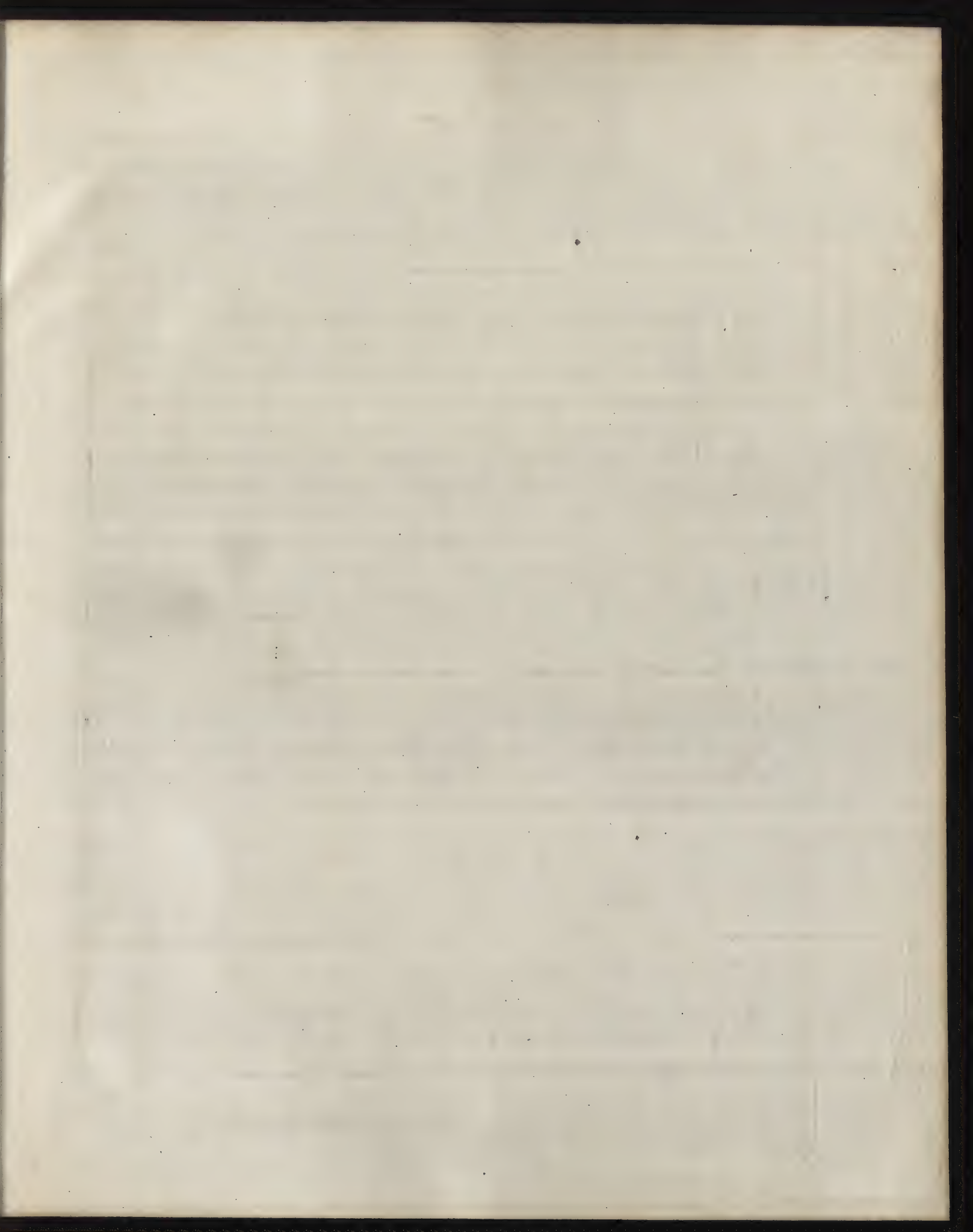
ready seen) being sharp Gravel, the Floods swept it down as before-mentioned, and indeed, the only Thing surprizing is, that it stood so long.

Now I am come to one particular Circumstance, which I recommend to your serious Attention, as I shall hereafter endeavour to draw some useful Inferences from it. After we had got some of these Frames taken up, particularly the third, we found under the inner Part of it, a smooth Floor of clean sharp Gravel, hard and firm under our Feet; but when we thought to go on with filling the Floats with it, to carry it away, as we had done in the Bed of the River between the Piers, we found it very hard, and as the Shovel could not move it we tried the Pick; but when we had got a little further into it, the Pick made little Impression upon it, and when we got further into it, we found that we had no other Way to break it, but by undermining it, and then break it off in Pieces with the largest Sledge we had. The middle of it was an actual Petrification of about a Foot thick, but not so hard in the bottom as in the top. Some of the Piers were much more petrified than others, and particularly this, as being better guarded by the Base of the Effigy, and having imbibed the petrifying Qualities that soaked from it. The Grit or Grain of it greatly resembled that of a Mill-stone; but the Colour was just the same with the Bed of Gravel it lay upon. Where the Gravel partook of Mud, the Pier that lay on it was not near so hard, and those Piers did not petrify at all that lay on Beds that were not gravelly.

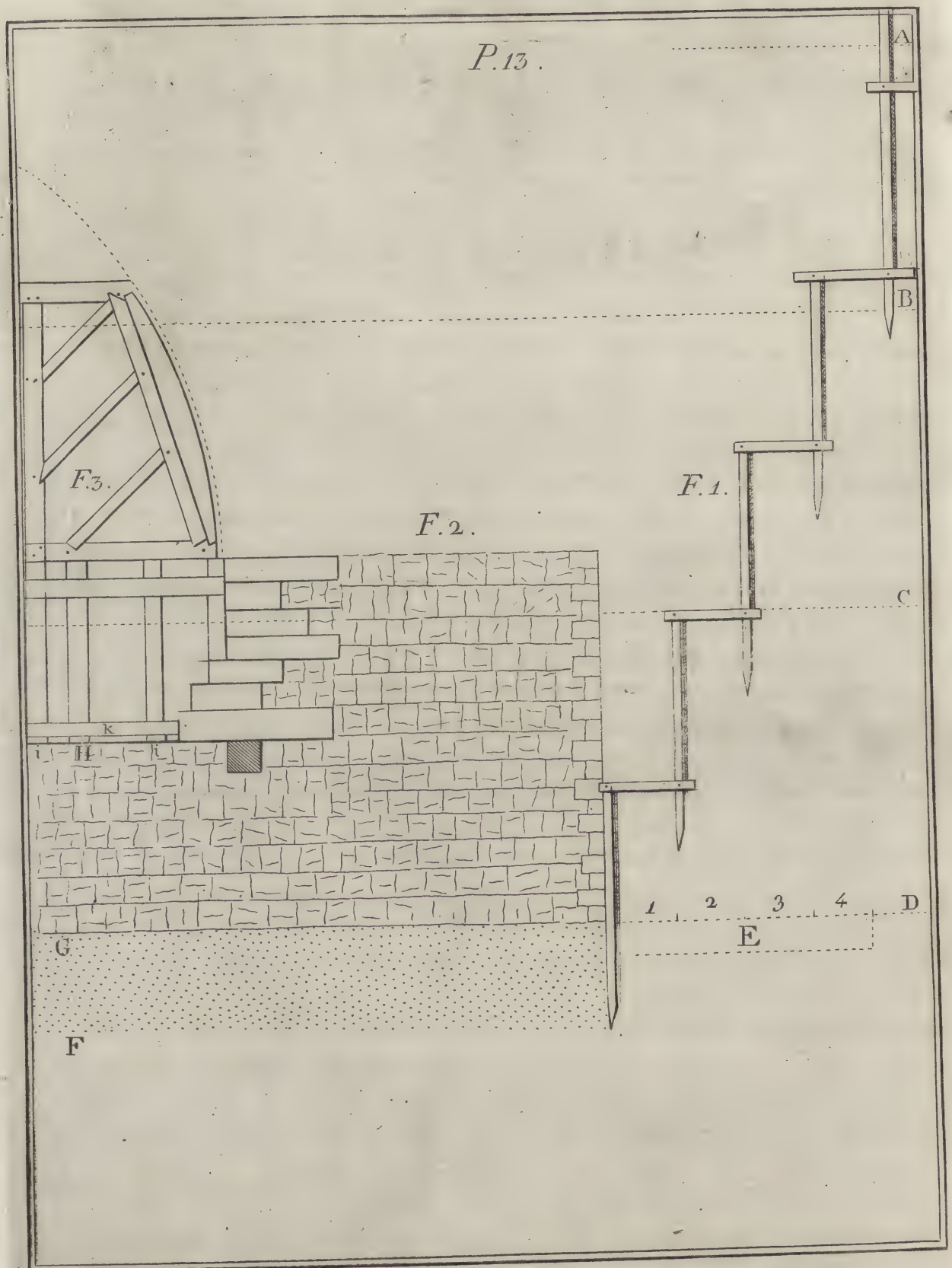
S E C T. III.

Breast-work for the North Abutment, shewing the Method of keeping up a Bank of loose made Ground upwards of 30 Feet high, on only ten Feet Projection.

WE began June 8th, to sink for the Abutment, which was a Piece of Work I was afraid would be attended with very great danger, because I had a very great Depth to sink, and very little



P.13.



little Room to sink upon, without depriving the Public of the use of the Carriage Way.

EXPLANATION of PLATE XIII. *Scale 5 Feet 1 Inch.*

In this Plate, Fig. 1. represents the Method I took to keep up the Breast of the Bank, wherein note, A. Pavement. B. High-water Mark, which is 9 Feet 4 Inches from the same. C. Low-water Mark = 10 Feet. D. Bottom of the Pit 11 Feet, that is = 31 Feet 4 Inches. E. Is the whole Projection of the Breast-work, which is 10 Feet, and that I divided into 4 equal Parts, allowing $2\frac{1}{2}$ Feet to each Stage. Having strained a Line at right Angles to the intended Bridge, and 10 Feet from the back of the Abutment, we sunk about three Feet, and then drove in a range of 4 Inch Piles close to the Bank; then with paving Hammers we chipped off so much more of the Bank as just barely admitted the sheeting to slide down between the Bank and the Piles; and when we had sunk 8 Feet in this Manner, we made our first set off $2\frac{1}{2}$ Feet, and proceeded in the same Manner as you may perceive by the Draft; but after we had got down to the third Stage, we always kept Braces against the Breast-piles, which we removed down according as we sunk; and notwithstanding the almost constant running of Carriages, and the Banks being all made Ground, there did not fall one Handful of it in upon us. When we had got down to about the third Stage, or a little under Low-water Mark, we had all above us composed of various sorts of made Ground; but from and about that level we found the Ground begin to incline to fine sandy blue Clay, sometimes mixed with Shells, and sometimes with Leaves, which we took to be Bay-leaves, all of which, we concluded had in former Times been left there by the Sea and River, because we got in it a small Tree almost rotten, with some of the Branches still upon it; at the Butt it was about 4 Inches Diameter, but no one could tell with Certainty what sort of Wood it was of; from all which, I concluded that I did not raise any fresh or natural Earth.

It is not my Intentions to give a minute Detail of all the various Circumstances relative to our Proceedings, for that, perhaps,

would be more tiresome than instructive; and therefore, I only give a concise Abstract of a few Particulars taken from our Diary, in order to convey a just Idea of the whole of that Work; but having made one very extraordinary Discovery in this Place, which alarmed every Man in the Work, and greatly surprized a vast Number of Gentlemen that saw and examined it, I shall relate the principal Parts of it in the next Chapter, and reserve the Explanation of Fig. 2. for a more convenient Opportunity.

C H A P. VII.

An extraordinary Discovery at eleven Feet beneath Low-water Mark.

HAVING got some Part of the North End of the Pit sunk down to about ten Feet beneath Low-water Mark, and quite free from Water, except some small Quantity that soaked from the Bed of the River, which was then about the same Space above us, and that we conveyed into the S. E. Corner for the Screw-pump; the Men that were sinking for the Land Abutment perceived one Spot in the Ground that grew very wet, but did not much regard it; but in sinking the next Spade which was about a Foot deeper, when they had laid open that wet Spot, we were all greatly alarmed by the very strong boiling up of the Water just in that Place. I sent immediately for my Book of Borings, and found that wet Spot was Boring N°. 28. I immediately called for one of the Boring-pipes, and had it drove down to the Rock, and the top of it was $3\frac{1}{2}$ Feet above that Floor, on driving of which the boiling entirely stopped. This gave us some Spirits, and the Men went on with their sinking that Floor, but at this Time the Tide was at Ebb; but when the next Tide rose to about six Feet, it began to boil over the Head of the Pile, and increased in force as the Tide rose, and so greatly wet the Work that we found it advisable to plug up the Pipe, and so we continued to hurry on the Work, without taking any further notice of the boiling, except looking on our *Jetteau* as a Matter of Curiosity, which during the Time

Time of High-water and after it, when we would pull out the Plug, would play upwards of a Foot above the Head of the Pipe with great force.

The Rev. Doctor *Hudson*, who was a very curious and constant Observer of our Proceedings, came to the Work the next Morning, and I brought him with several other Gentlemen to the Work, to see our curious *Jetteau*: He called for a Glass, and they all tasted, smelled and attentively observed its Colour. They then dropped a Piece of Silver into the Glass, which was soon turned to a dark yellowish Colour; and at Length, they all concluded that it was a mineral Spa, and advised me to send directly for Doctor *Rutty*, for whom I went myself, and he cheerfully came with me, the Gentlemen waiting for us: He tried all the before-mentioned Experiments over again, and acknowledged, that it seemed very like the Water of *Swaddling-bar*; but concluded, that any Sea-water that partook of putrid Water, running from a foul Sewer, might have the same Effects that had, and he desired me to send some of it home with him, which I accordingly did.

This Affair engrossed my whole Attention, and put me upon making the following Experiment. See Plate 4. Boring N°. 28, and see that N°. transferred to Plate 5. which is the Boring mentioned above. I then had two other similar Pipes drove at ten Feet distance from it to the East and West, viz. 29 and 30, and I bored them in the like Manner at Low-water, and as the Tide came in, I found the Water rise in all the three Pipes exactly alike, and at or soon after High-water, they all played together when we took out the Plugs, near a Foot above the Heads of the Pipes, which were all on a level; and as the Tide fell, they abated in their Force, but never sunk lower than the-tops of the Pipes, which as I said above, was 3½ Feet higher than the bottom of the Pit, and consequently 7½ Feet under Low-water Mark.

The next Morning Doctor *Rutty*, and Doctor *Hudson* came to the Work, where they met the Gentlemen that were there the Day before, and he, Doctor *Rutty*, then assured us, that it was no Species of Spa-water, but he believed, a large Body of subterraneous Water, that ran along on the Surface of the Rock, and communi-

cated with the Sea-water, and partook also, of the foul Waters of the Bed of the River and the Sewers. He then produced us as much Salt as would cover a Shilling, which he said, he had extracted from one Pint of that Water, which was not near so much as a Pint of Sea Water would produce; and concluded with giving me this friendly and useful Caution, "take great Care that you do not let that Water break up upon you, for if you do, you will never conquer it."

This Opinion of Doctor *Rutty's* corroborating with my own, it was instantly circulated among all the Men in the Work. They all unanimously joined in exerting themselves to the utmost of their Abilities; for that Water alone, was not the Cause of our Anxiety, as we were at that Time thirty-one Feet deep under the Surface of the Pavement, which was within ten Feet of being perpendicular over us, and all being made Ground, with a fine Sea sandy bottom, which notwithstanding all the Precautions we had taken in sinking and shoring up our Breast-work, we well knew, that if the smallest Quantity of Water should then get into the Pit, it would most assuredly sap and soften that fine Sand, which together with the continual shaking of the Ground by the Carriages, would render it impossible for us to prevent its bursting in upon us, and in all Probability pull in the Corner-house along with it.

Hereupon we agreed, that it would be best and safest for us to desist from sinking any deeper, though that was no small Disappointment to us, as we then had thoughts of going down to, or very near the Rock, nor otherwise had we any Difficulty to encounter with in accomplishing it; for the Floor we were then levelling and clearing out next to the Bank, was perfectly free from Water, except what little sprang up with the three Pipes; but remembering Doctor *Rutty's* Caution, which I knew to be well founded, I proceeded with all possible Expedition to make the Masons secure the bottom of the Breast-work.

September 23, The Masons began to lay the thorough Foundation, but particularly to secure the bottom of the Breast-work, which extended about 15 Feet from the Bank, and in the mean Time the Labourers were clearing out and levelling about 20 Feet
more,

more, which being just accomplished they were hurrying in Stones to be ready for the Masons, except one Man, who was left to throw out and level some small Matter which they left undone; but all the alarms and frights we had met with, were nothing to a fresh Discovery which that Man first observed; the Floor (which was clean, smooth and dry) opening, I was instantly called, and when I got on the Spot, could clearly perceive the Ground swelling up and opening, (See N^o. 31, in Plate V.) and it soon extended to about the Length of 10 Feet, turning rather southerly at the West End, and the Crack or Opening was about three or four Inches wide in the Middle. The Tide was then about ten Feet high, and in the Middle of the Crack we found the Water beginning to spring up, which gently increased to about a Foot Diameter, and sprang pretty fast. I called for another Pipe of the same Length, and had it drove down in the Centre of the Ebullition, or Boiling up, till it came to the Rock, and having bored and cleared it as before, which eased and gave it vent, we found the Water rise up, and in Fact the very same sort as came up in the three former Pipes, and to the same level, altho' this Pipe was 17 Feet to the South of them; and we plugging up this Pipe also, the Men did all in their Power to get in Stones and Mortar ready for the Masons, and in the mean Time the Water that sprang up through the Crack, rose 18 Inches deep in the lower Part of the Pit; but providentially we then had the Masonry built above six Feet high against the Bank; but when the Ebb came it desisted, and we soon got out the Water, and laid the largest and flattest of our Stones upon the Crack, spreading some Litter under them, and before the next Tide had that Part of the Foundation almost as high as the other; for, from the Time of our getting the Bridge taken down to High-water, we wrought both Night and Day, without one Minute's Intermission, as we had two sets of all sorts of Men that relieved one another alternately every eight Hours, not excepting even Sundays, when our urgent Occasions required it: Yet, notwithstanding we had luckily conquered that subterraneous Water at so critical a Time, it never failed every Tide, whilst we wrought in that Pit to contribute greatly to the increase of the Pump-mens Labour; but as

we

we wrought with unremitted Perseverance and great Expedition, we most fortunately prevented its bursting up upon us. And of this I am well assured, that if we had not that Instant loaded that opening of the Ground, the subterraneous Water would certainly have broke in upon us, and if it had, there could have been no Kind of Possibility of ever building a substantial Bridge in that Place, considering the Condition that every Thing was then in, and so many thousand Pounds worth of Labour and Materials would have been totally lost, and our then hopeful Projects entirely at an End, as Doctor *Rutty* had told us.

C H A P. VIII.

A Continuation of the Abstract of our Diary, and laying the Foundations of the North Pier, 21 Feet beneath the usual High-water Mark.

WE made the first Trial of our Cofferdam on *June 27th*, and it kept out 3 Feet 6 Inches of that Tide. *July 3d*, we screwed down the Sluices when it was High-water, and kept them down till half Ebb, in which Time the Water in the Dam fell three Inches, and thus we tried and proved its Stanchness several Times, both backward and forward; but the South East Corner of it that stood on the great Depth of Stones that had been carried down by the Floods into that deep Pool, was like a *French Drain* (as before-mentioned) which we began to despair of ever getting made even tolerably stanch.

July 7th, we screwed down the Sluices at low Water, and before high Flood, discovered that the Tide Water had wrought its Way in under that South East Corner through the Stones and Rubbish of the old Bridge, and began to spring up about 20 Feet within our Dam after a very furious Manner; on the first Appearance of which, I ordered the Sluices to be screwed up and let the Tide in, by which we drowned the Springing, which did us very little harm; and at low Water I set all the Drudge and Water-men to that Corner, both without and within, and in short, we took out and removed

moved from that Corner every Stone that was in our Power, and filled the Vacancies with Clay, &c.

Aug. 3d, The Sluices were screwed down at low Water, and when there was nine Feet Flood without, the Water had rose only thirteen Inches within.

5th, After an exceeding heavy Rain there came down a sudden rapid Flood, and tore away many of the Ships and Lighters from the Quay, snapping their Moorings as a burned Pack-thread, and did them great Damage, but we were prepared for it, and kept open our Sluices, so that the Water then rose as fast within as it did without; but it did us no other damage than delay us a little, and wash away some of our Clay; and after all this, the next Day we proved the Dam again, and during the whole Tide, the Water within rose only four Inches.

EXPLANATION of *Fig. 2. in said Plate 13.*

Wherein note, F. The Rock. G. Strata of fine sandy Loam, which is in this Place, three Feet six Inches thick from the Rock, on which the rough Stone Work begins. H. The last Course of the rough Stone Work, which is laid with very large Stones carefully bedded and wrought close in their Joints, to guard the thorough Foundation between the Piers from ever being displaced, or torn up by the Water, which is about four Feet deep at low Water. *i. i. i. Fig. 3.* Are the Ends of three Four-inch Planks that stretch quite a-cross the Foundation, and on which the Sills of the Centres k. rest. When you are doing the like Work, observe that between these running Planks and Sills, to lodge in Wedges of about 2½ Feet long, leaving about one Foot of them out, and when you come to strike your Centres, describe or mark them deep, that you may know how far you bring each of them out, by striking each Wedge on each Side, and by that Means you will work out the Wedges by Rotation, till you have eased every one of them about one Inch, and then proceed after the same Manner, till you have eased them all about another Inch, and so proceed till you have got them all out; after which you may go on with taking them down after the usual Manner. And this I recommend as a much safer

safer and a more practicable Method, than Screw Wedges, which some have very warmly recommended.

September 28th, at 3 o'Clock in the Morning we set the first Cut-stone of the Land Abutment, without any Parade, which Time would not admit of.

November 1st, we compleatly finished the North Pier, springing high, and cut the six Inch dovetail Piles, that cased the thorough Foundation just at the Surface of it, half through, so as we might easily break them off there when we pleased.

6th, We took up the strait Beams that went a-crofs the Pit, in order to let the Carpenters put up the Centres of the North Arch.

EXPLANATION of PLATE XIV. *Scale 5 Feet 1 Inch.*

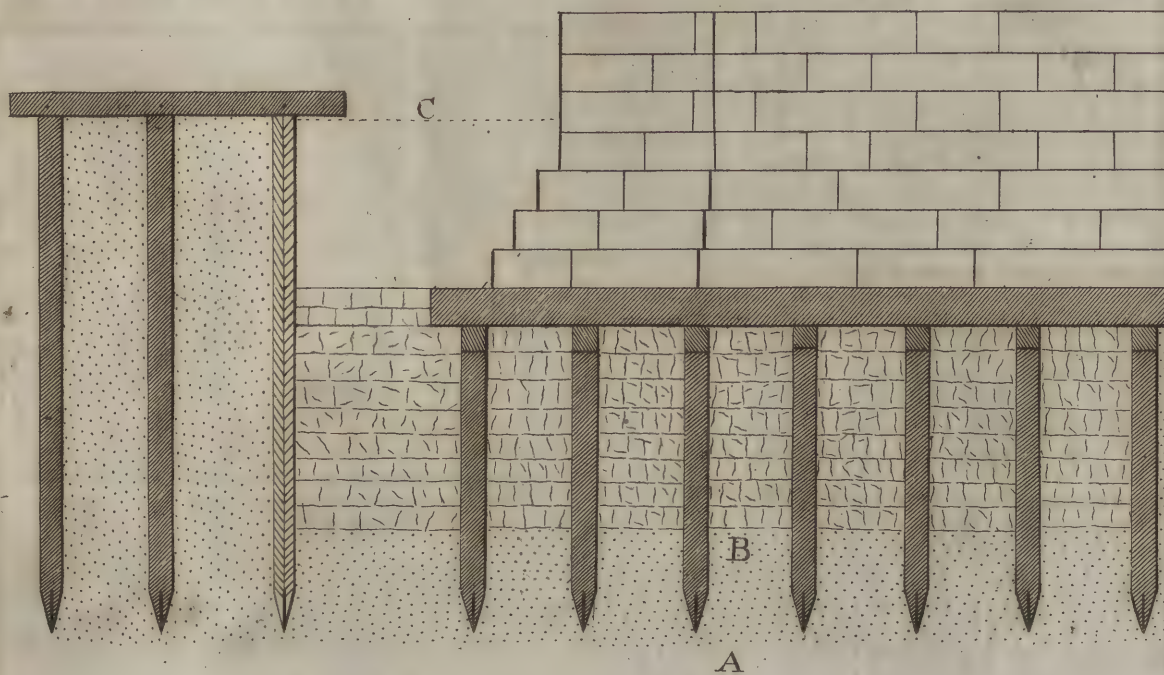
Fig. 1st, Represents the Plan of the Foundation of the West end of the North Pier, with the rough Masonry wrought up about the Piles, and inclosed with a Row of six Inch dove-tailed Piles, such as you will see in Plate XV. *Fig. 6.* which were half cut off at the Surface of the thorough Foundation, and then broke off, leaving the lower Part to case and guard that Foundation. The other two Rows of square Piles and their Sheeting, hold the Clay, which together make the inner Coffin or Pit. *Fig. 2.* Section of the same, and the West End of the Pier. Wherein note, A. Rock. B. The Bottom of the rough Masonry. C. Low-water Mark, which is eleven Feet from B.

EXPLANATION of PLATE XV. *Scale 5 Feet to 1 Inch.*

Wherein note, *Fig. 1.* Shews the Bond of the Cut-stone in the bottom or first chained Course, of the Pier, with a Part of the rough Stone Foundation, covered over with large thick Stones Home to the dovetailed Piles, the Surface of which is four Feet six Inches beneath Low-water Mark. *Fig. 2* and *3.* shew the Bond of the Cut-stone in the other two Chain Courses. The Chain of the first Course was near three Inches Square, and the Chains of the other two about 2 Inches Square, and all sunk their full Depth,
and

P. 14.

F. 2.



F. 1.

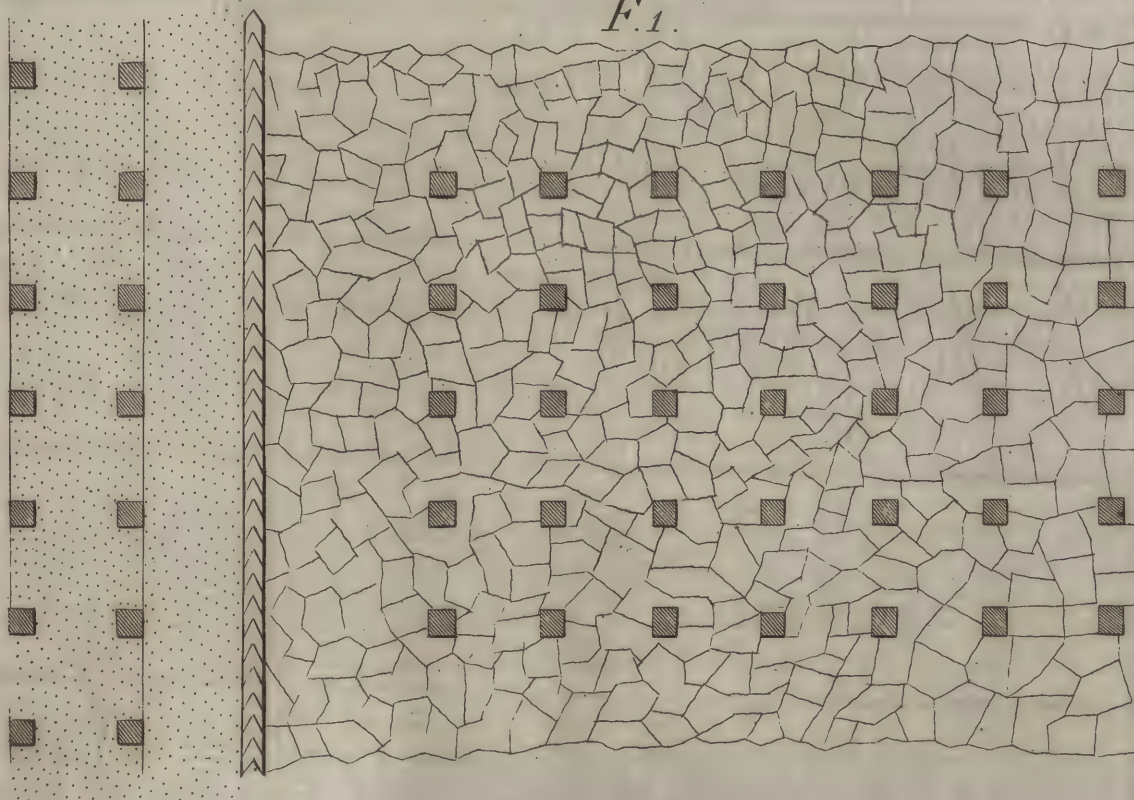


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Table with 2 columns and 5 rows of faint text.

P. 15.

F. 3.

F. 4.



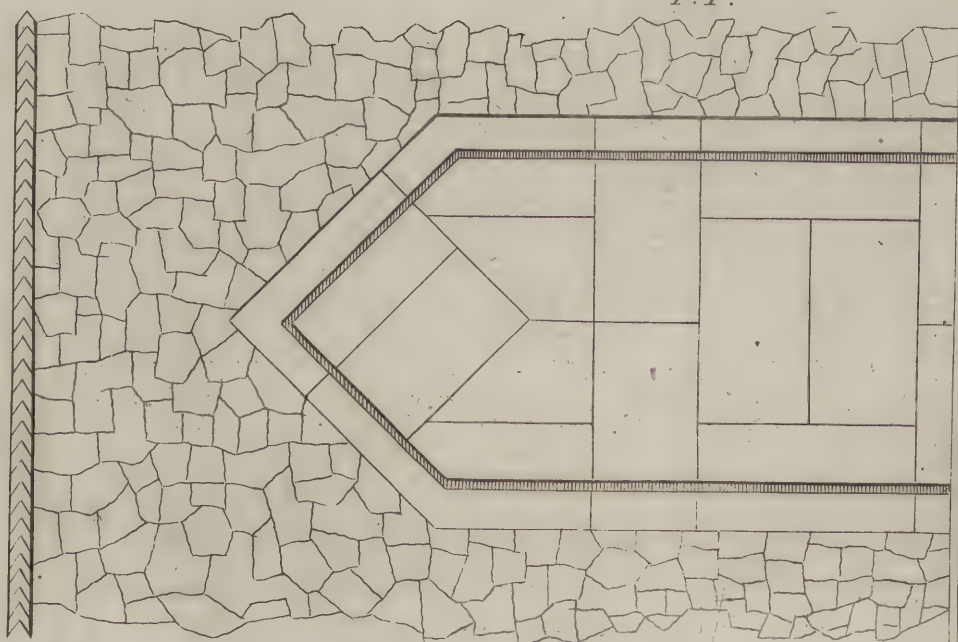
F. 2.

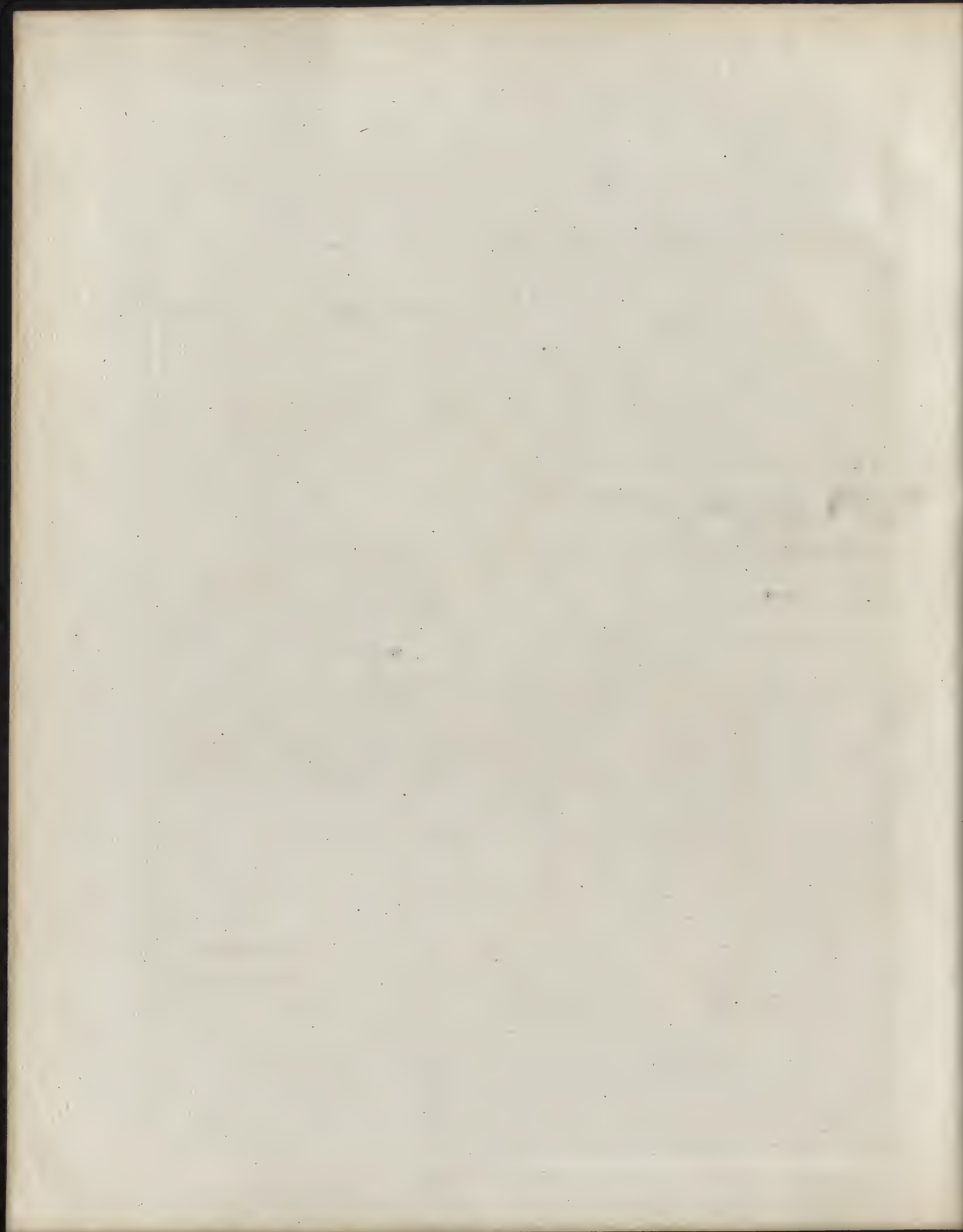
F. 5.



F. 1.

F. 6.





and run with Lead. Fig. 4 and 5. are two different Methods of making dovetailed Piles. Fig. 6. is the Method that *Belidor* seems to have made use of, and I followed the same; but in my Opinion, Fig. 4. is both the best and cheapest, for many obvious Reasons.

The Method we took in laying the Foundation, was this; after we had drove the Oak Piles down to the Rock, which you saw in the last Plate, we spread a plentiful Coat of Roach-lime and sharp Gravel over the Ground, and laid a Course of large flat Stones, and filled and hearted them in close about the Pile for about a Foot high; then we covered that Course with another plentiful Coat of the dry Grout (i. e. the Roach-lime and sharp Gravel) and the next Course and all the rest was laid with Mortar after the usual Manner, only with this Difference, that every Stone swam in Mortar, and each Course was grouted as above; and so we went on till we came to the level for the Caps that were laid over each row of Piles, and then wrought up and levelled them, on which we laid three Beams stretching the whole Length of the Pier from Sterling to Sterling, and filled up about them with the Masonry; but the thorough Foundation that lay under the Arches, was laid and securely bedded, and many of the Stones were rather pitched upon their Ends and wrought close together, so that there is a substantial Stone Floor for the Bed of the River between the Piers, on which we spread a Course or Stratum of about a Foot thick of sharp coarse Gravel mixed with new and old Lime-rubbish, and we covered that with a plentiful Bed of such coarse gravelly Stuff as we could collect within the Dams, which together, made on an Average about $2\frac{1}{2}$ Feet thick; my reason for laying this covering on the Surface of the Foundation, was principally to preserve the green Mortar that lay on that Surface, from being washed away before it would get proper Time to cement; and as I had $4\frac{1}{2}$ Feet from that Surface to the Low-water Mark, I concluded, that for the present Time two Feet deep would answer the Purposes of Navigation, and we finished all the rest of that thorough Foundation in like Manner, except the South Arch.

I am sensible there was no sort of Necessity for piling this Foundation, as there was such a Depth of Masonry under the Piers, however, as it could not be so strong as on the South Side, where

H

they

they were built on, or very near the Rock, I thought it advisable (as we had plenty of Piles) rather to err on the safe Side.

C H A P. IX.

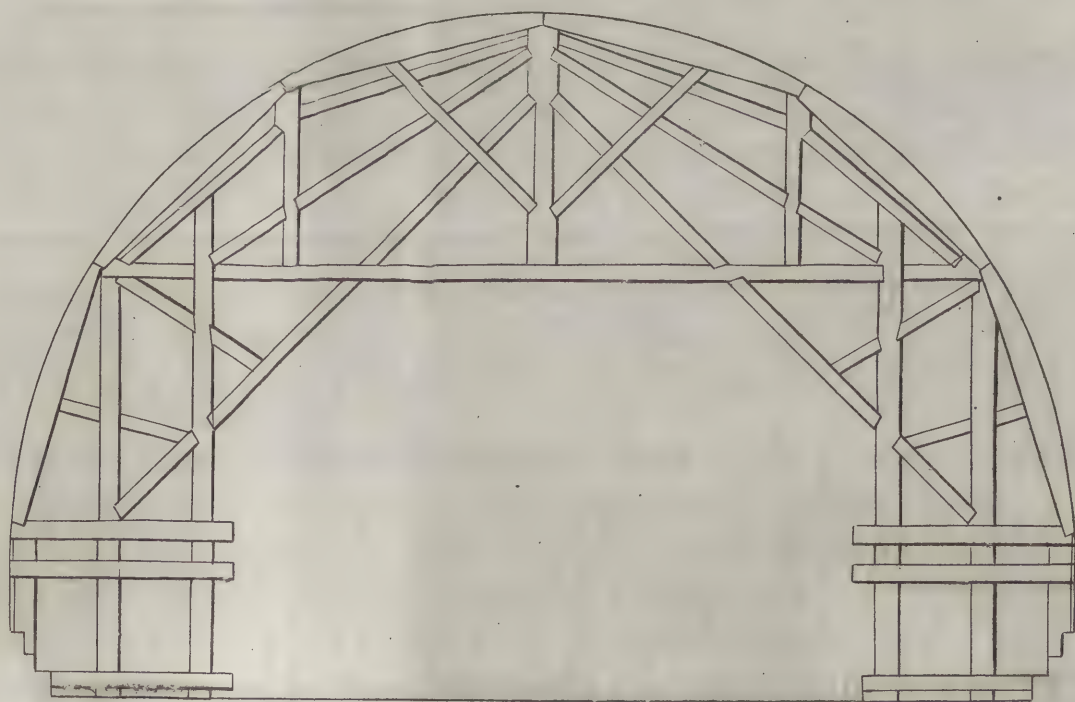
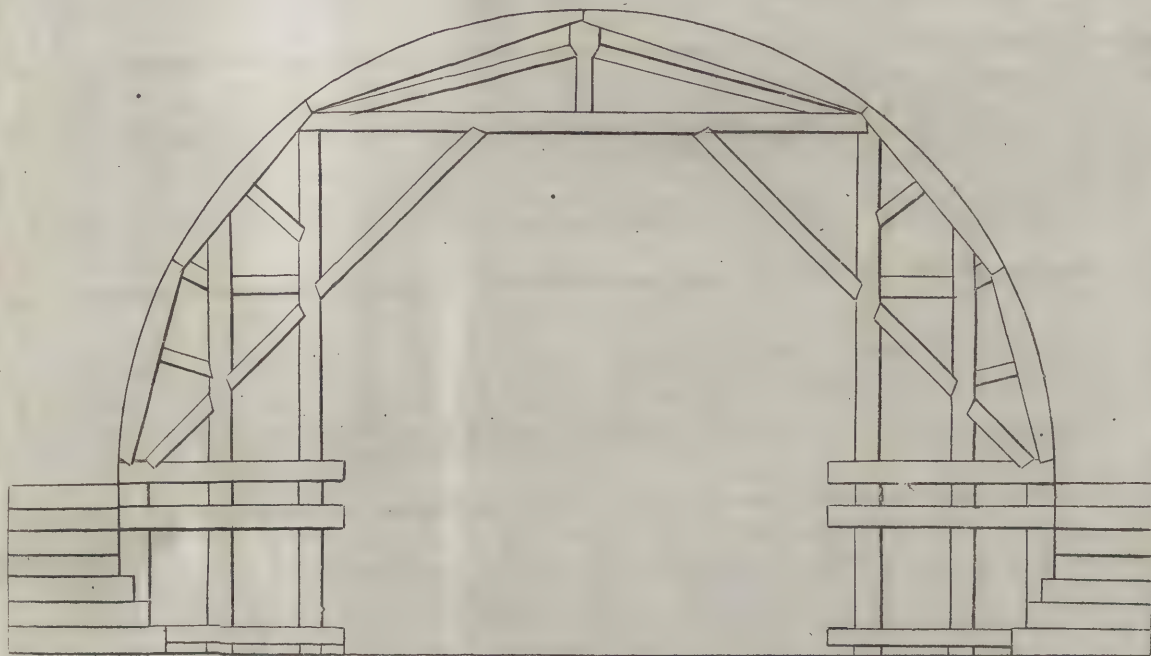
Concerning different Methods of centering, for large Stone Bridges, and a Continuation of the Abstract of our Diary.

THAT Part of a Centre, which I shewed you in Plate XIII. Fig. 3. is sufficient for our present Purpose; but such Centres are only proper where there is such a Foundation, but in other respects it would not answer.

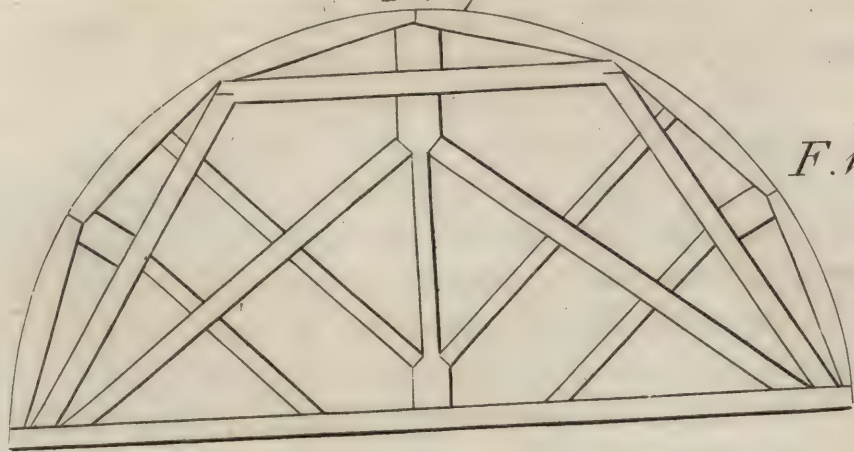
In Plate XVI. (Scale 8 Feet 1 Inch) you have two other Methods of centering with Crown Beams, the Prick-posts resting on 4 Inch Plank stretched parallel to the Piers upon the thorough Foundations, as above-mentioned; but in Case you have not such a Foundation, your whole Dependance must be upon your Piers, as in Plate XVII. (by the same Scale) in which you have three different Designs; and notwithstanding they are drawn for 36, 41 and 46 Feet Spans, yet if you consider every Thing in Proportion, they may very well answer for double those Spans: And I apprehend, that Fig. 2. shews you a very safe Way to support them, *viz.* In the three projecting Courses of your Piers, make your upper set off about 10 or 12 Inches, more or less, according to the size of your Arches, as at *a. a.* and on those set-off's stretch your Plates, and on them rest your Spur-braces as in the Draft, never forgetting to put in the Wedges before-mentioned, for in Truth, no Centres ought to be put up without them; for by easing your Centers gently, every Part of the Arch has Time to come to its proper bearing, and many an Arch as well as Vault, has been dislocated by striking them abruptly.

December 4th, There came down a terrible Flood, but we expected it from the heavy Rains we had, and prepared for it. The first high Water afterwards rose to 12 Feet 6 Inches, and every high Water afterwards rose to 12 or 13 Feet for six successive Days, and even at low Water the Floods kept up to 8 or 9 Feet, during all

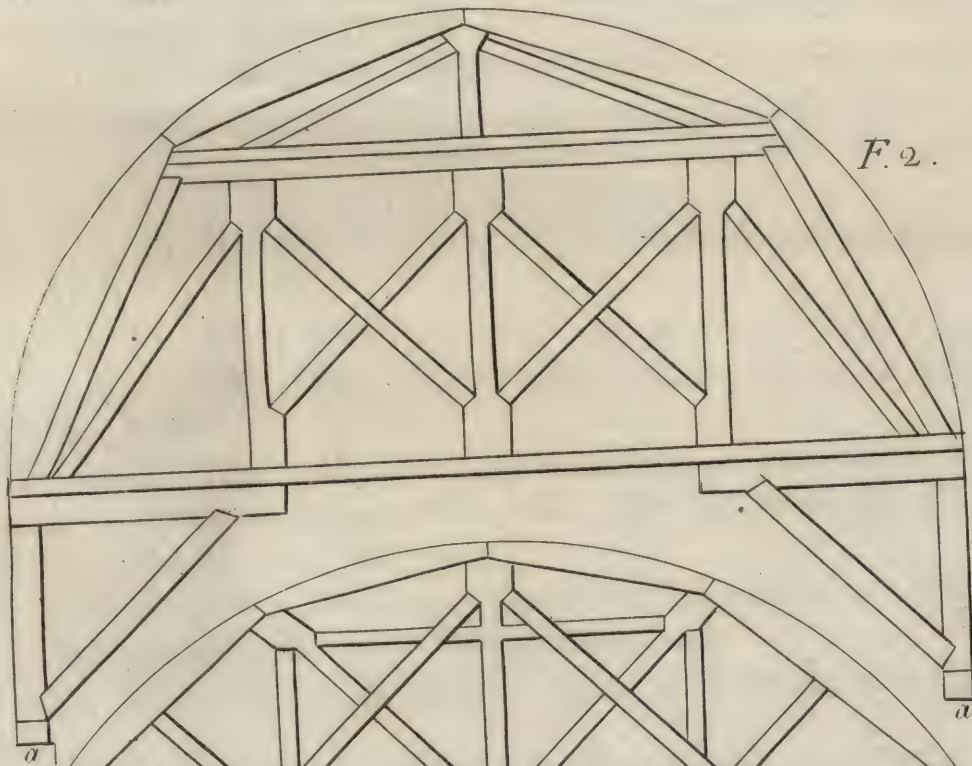
Pl. 16.



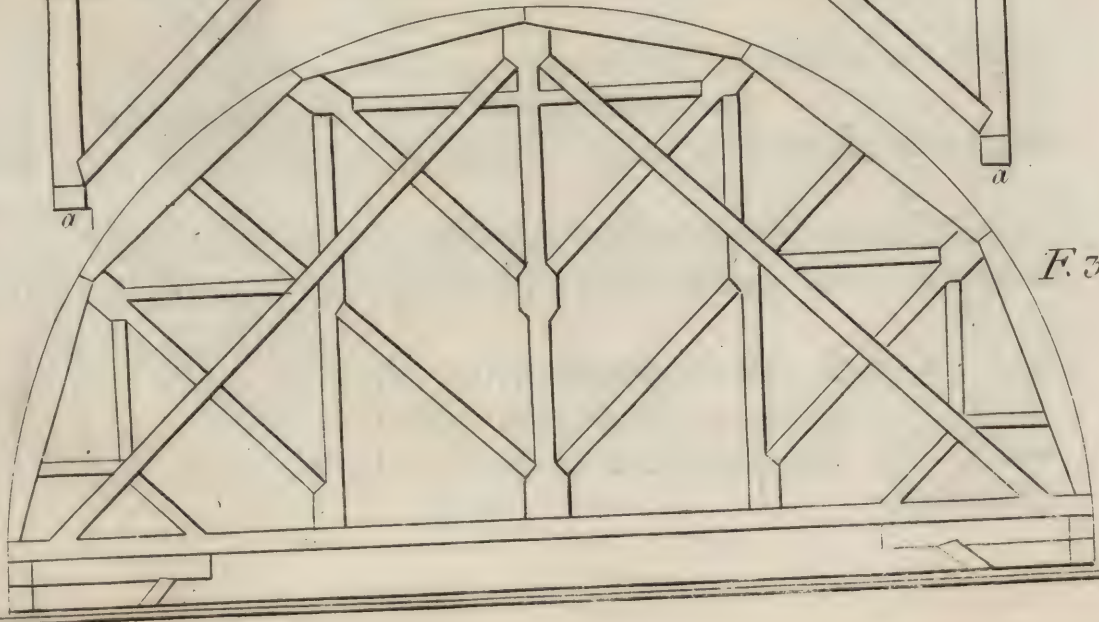
P. 17.



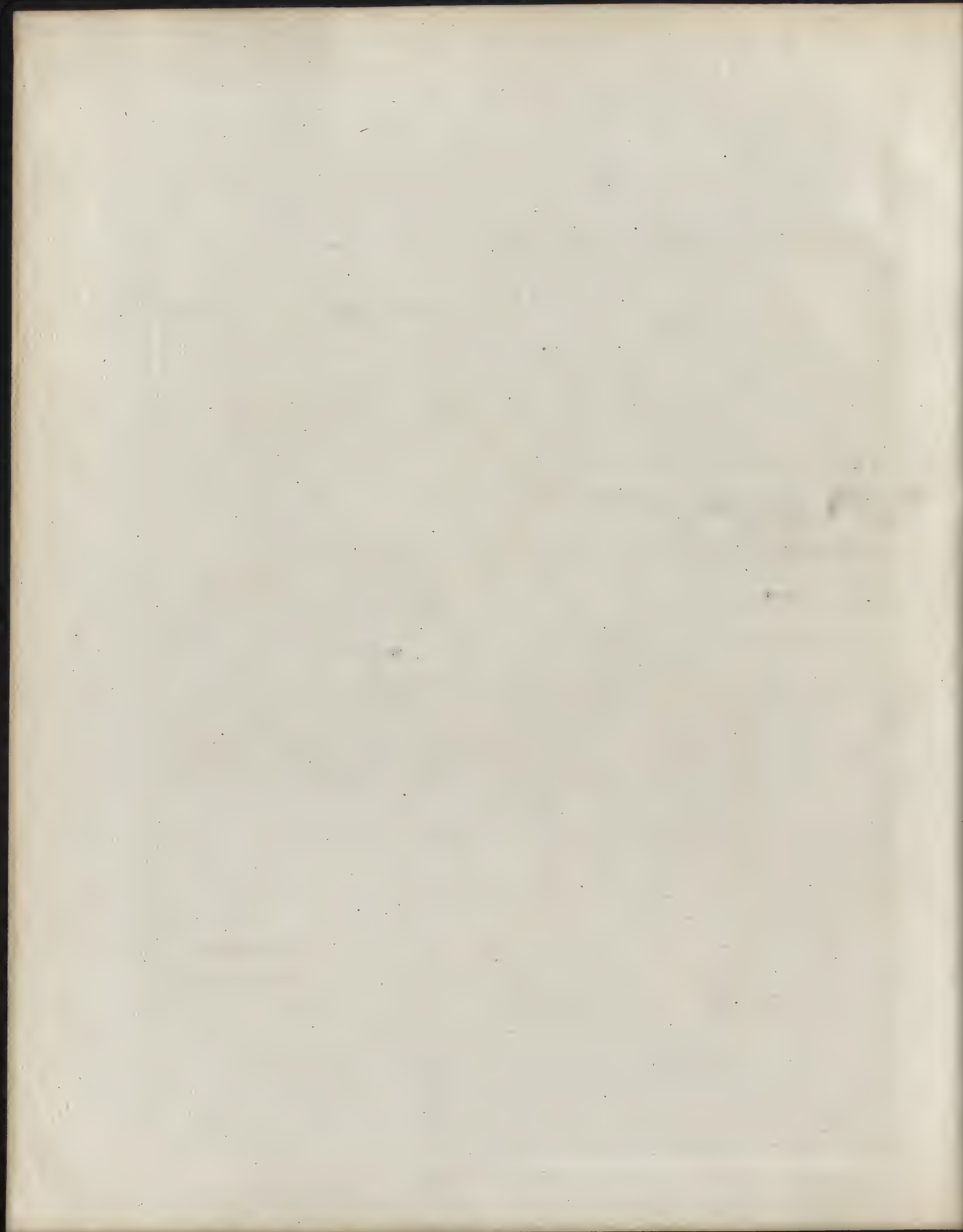
F.1.



F.2.



F.3.



all which Time, our Sluices being open, we suffered little or no Damage, except loss of Time, and the disturbing our Stages, Utenfils, &c. for all the Water being at the same level within and without, it was perfectly still and quiet within the Dam.

From the 4th of *December* 1753, to the 23d of *February* 1754, the Floods continued extremely high, and often to 13 Feet at high Water, which greatly retarded our Work; but otherwise, did not do us any considerable damage: However, we were now enabled to put the rough Mafons to get ready the Foundation of the second northerly Pier, which we executed just like the former; and within the Space of four Nights and Days, we had it ready for the Stone-cutters, that is, on the 27th, the Stone-cutters laid the first cut Stone of the 2d northerly Pier.

March 19th, We began to drive the first of the Piles of the Cofferdam for the 2d principal Operation on the South Side. See *Plate XVIII. Scale 40 Feet 1 Inch.*

29th, Second northerly Pier springing high.

30th, The Stone-cutters began to lay the first Course of the 2d northerly Arch.

April 8th, The Coal-gabbards were stopped for the first Time, and missed three Tides, when we cleared a Way for them under the northerly Arch.

22d, They began to pull down the Excise-office; by the delays given to us on that Account, we lost eight Days of the finest Weather we had had for a Year past.

25th, Part of the Custom-house Quay fell, by which we discovered another old Quay-wall, 6 Feet within that.

May 23d, Both the North Arches open and free for the Coal Gabbards.

25th, There came down a sudden rapid Flood from the Mountains, which washed away a great deal of the Clay, which we were putting in the Cofferdam.

June 5th, From the 25th of last Month to this Day, we had constant Land-floods; the Ebbs seldom fell under 3 or 4 Feet. These Floods destroyed a vast deal of the Clay, but with great

Difficulty we got the Current turned entirely into the North Channel, to its full Depth.

14th and 15th, The Land-floods at Low-water were from 8 to 9 Feet.

25th, This and former Days we had great Labour in taking up the Ridge of loose Stones, which lay in a direct Line quite a-cross the River below Bridge, as before-mentioned; but dear bought Experience had taught us to spare neither Time nor Cost to get those dreadful Pests removed from under the Dike.

July 27th, These six Days we had exceeding rapid Mountain Floods; high Water generally about 11 Feet.

August 4th, We finished the rough Stone Foundation of the South Pier of the middle Arch.

5th, The Stone-cutters began to set the same Pier.

12th, In drudging for the South-east corner of the Dam, we met with very large Cakes of the petrified Sand, that the Floods had carried down into the deep Water, which they were forced to break to smaller Pieces, by driving well-shod Piles into them.

28th, We stopped all the Pumps, as we had no further Occasion for them.

From the 20th to the 28th of *September*, we were obliged to stop the Carriages, from going along *Essex-quay*, on account of our sinking for the South Abutment, in doing which, we raised Part of the Foundation of *Newman's Tower*, which had been very judiciously laid on the solid Rock, and we were also obliged to quarry in some Places two or three Feet deep of the Rock, to bring it to a proper level, and omitted two Courses of the Cut-stone of that Abutment, as the third of the projecting Courses were laid upon the solid Rock.

October 7th, The Abutment finished, springing high, and the same Day we began to lay the Foundation of the South-quay Walls.

C H A P. X.

The proper Method of building Quay Walls, and a Continuation of the Abstract of our Diary.

I SHOULD think myself very reprehensible, did I forbear to discover the true Proportion of *Quay Walls*, which I was taught by an eminent and worthy Gentleman, Major *Marcell*; but previous to the Proportions, there are other Things to be considered, the principal of which is, the Nature of the Ground on which it is to be built, and to be sure, if it be not strong enough, that you make it so by piling, and that the Foundation of the Wall be laid of a sufficient Depth, the front Course of large and long Headers, that will admit of making a good set-off; all which being duly considered, you are then to calculate how far that Foundation is to project.

The Major's rule is this, "That the out-side of a Quay Wall, ought to batter one sixth Part of the Height of it." And lest you should not clearly understand this most excellent rule, I shall perhaps make it the more intelligible, by giving you an Instance of a Wall, that is to be twelve Feet high from the Surface, or level of the Foundation before-mentioned.

Every Foot your Wall rises must batter two Inches, then your 12 Feet high must batter 24 Inches, and to this add 18 Inches for the Thickness of your Parapet, which will make three Feet six Inches, for the Bottom of the Wall that stands on the Foundation, and allowing at least three Inches for the set-off, your Foundation must be three Feet nine Inches broad; observing that the back of the Wall is to be carried up perpendicularly, and the Stones laid firm, and after a Workman-like Manner against the Bank, for if you only build the out-side fair, and fill the back and inside carelessly, or perhaps, with a scanty Allowance of Mortar, that Wall could not stand long, let the batter be what it would.

In order to carry on this Wall properly, you are to make a Plumb-Rule fit for the Purpose, with one side of it Plumb, and the other
Side

Side to fit the battering Side; but if you are carrying on a new Quay Wall of any considerable Length, you ought to work by a battering Frame, always observing, that the top of your Frame (which we suppose to be 18 Inches broad) be exactly level to the level of the Bank, otherwise, you will find you will be either too broad or too narrow when you come to the Surface of the Bank; and indeed, all these rules ought to be observed in building a Wall against any other Bank. For suppose you build a Plumb Wall against any Bank, which I have generally seen practised, the Rain or Wet is continually carrying down a Quantity of loose Particles, which become a Wedge between the top of the Wall and the Bank; and like taking a Sword in the feeble of the Point, the further it goes the more Power it will gain, and thereby increase its own Purchase, till it at Length totally demolishes it.

November 1st, We began to put up the Centres for the two southerly Arches, and prepared to do the same for the Centre Arch.

January 10th, 1755, The Haunches of the two northerly Arches being compleated, we made a safe and commodious Foot-way to the Dike, which we railed in, and which proved of great Advantage both to the Public and our Work.

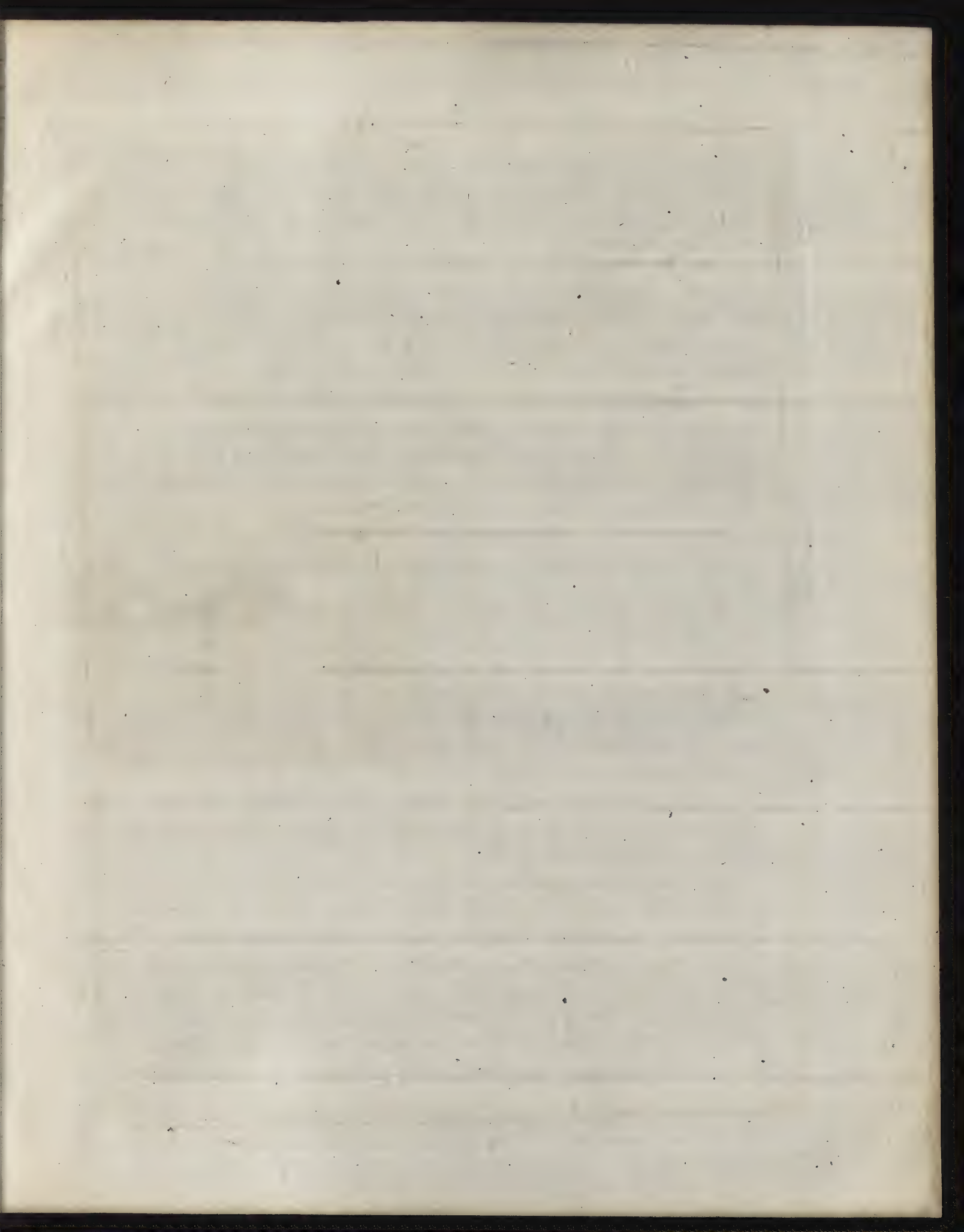
March 5th, The second South Arch was finished, and we began to build the cross Walls from the Crowns of the Arches, in order to make the Carriage Way.

April 1st, The middle Arch being almost closed, we employed Men and Carts to bring in Rubbish to raise the Pavement about the North End of the Bridge.

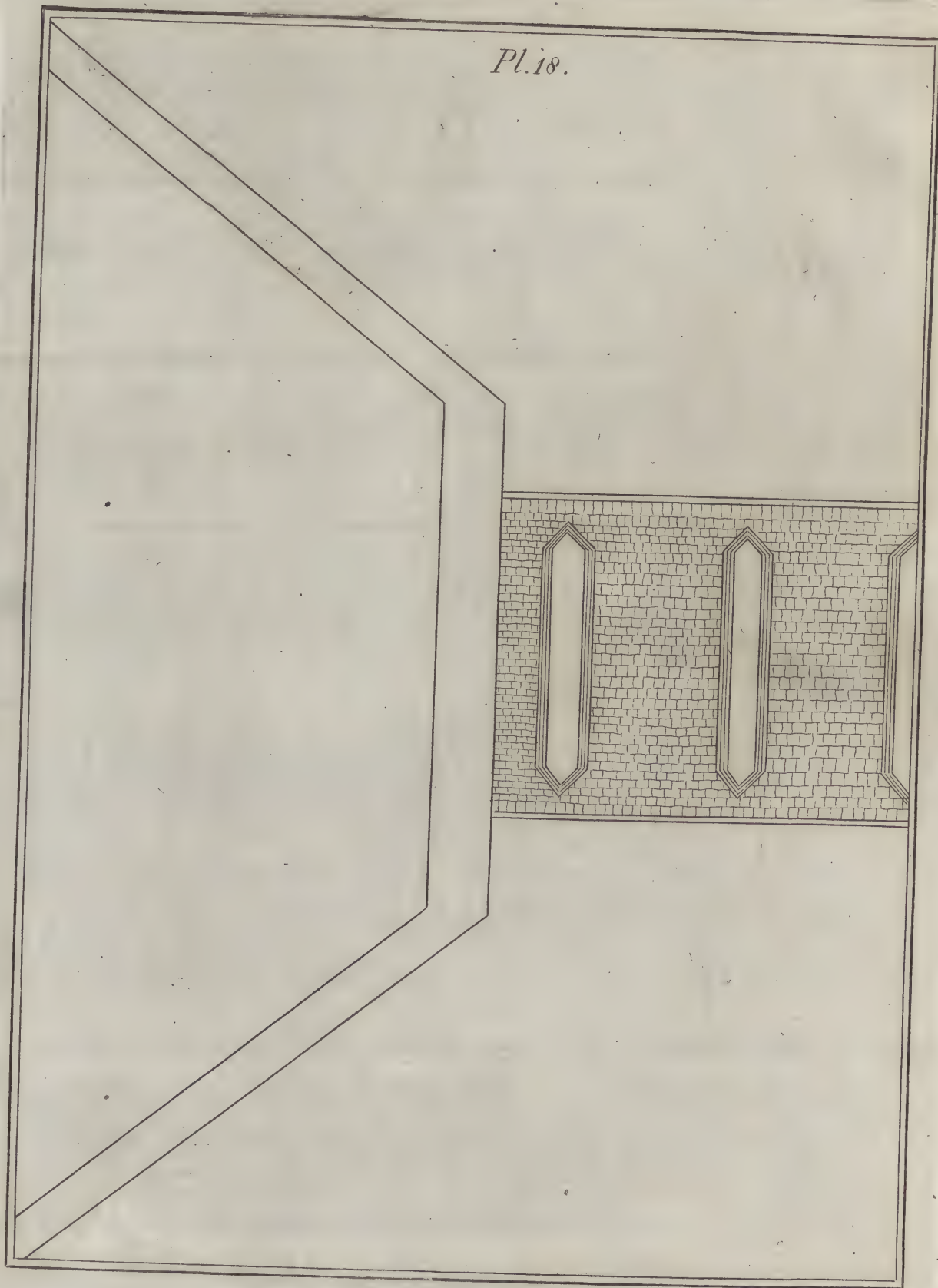
3d, The Paviour began to Pave.

8th, The last and Center Arch being closed, I immediately boarded in a Carriage Way of 20 Feet broad, over the middle of the Bridge, in order that the impatient Public might have the benefit thereof as soon as possible; and on the same Day, having got one Side of it paved, I invited the Right Hon. the Lord Mayor, being Alderman *Percival Hunt*, and the two Sheriffs to be the first three, as accordingly they were, that were drove over the Bridge.

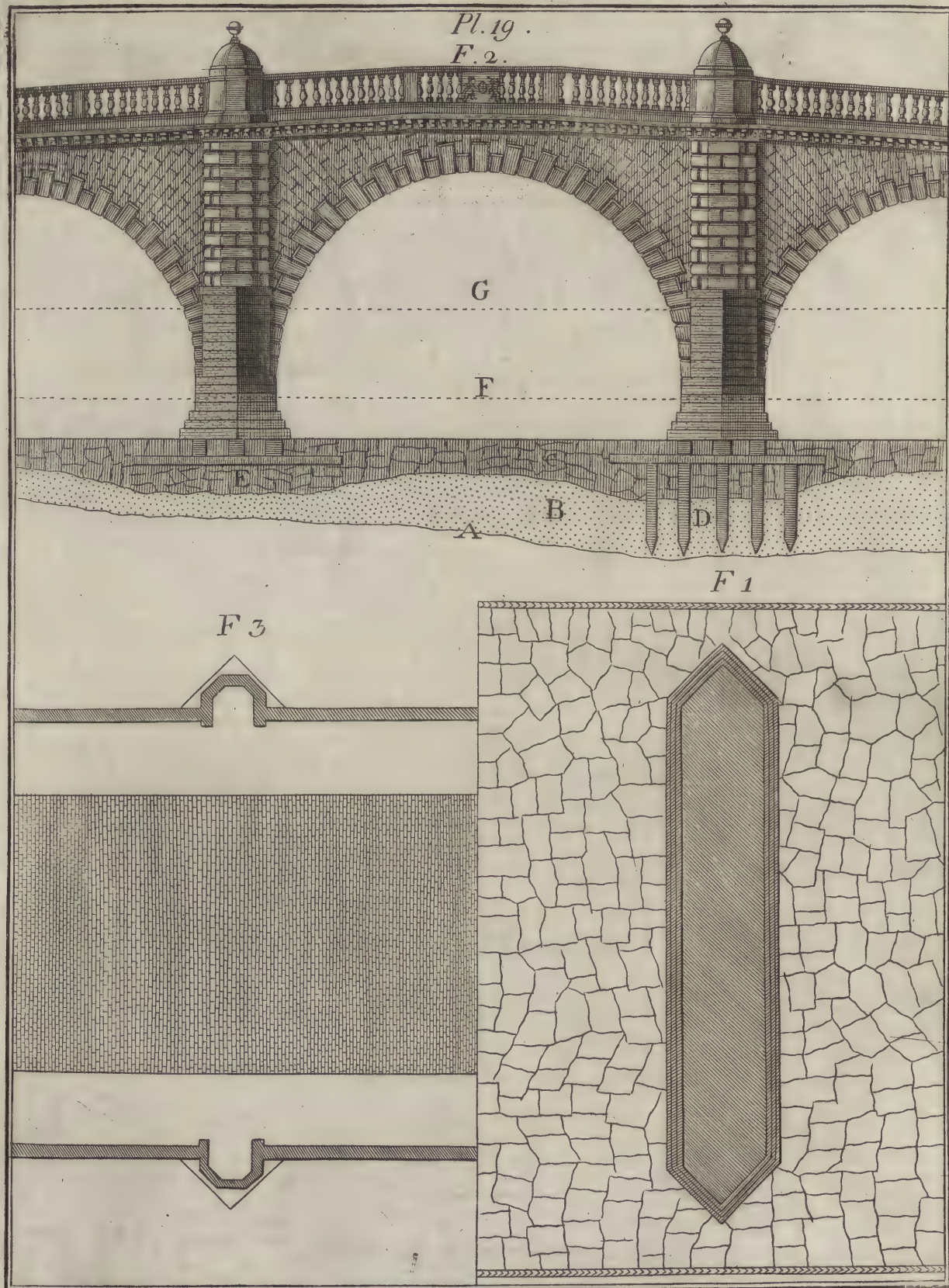
10th,



Pl. 18.







10th, The Bridge was left open for the use of the Public in general, which made two Years and eighty Days, since the Day on which they were deprived of the use of the old Bridge, which was *January 19th, 1753.*

EXPLANATION of PLATE XVIII. *Scale 40 Feet to 1 Inch.*

Shews you the second principal Operation with the thorough Foundation, Piers and Part of the Abutment to the Northward, and the new Coffe-dam on the South, on which I need not enlarge any further.

EXPLANATION of PLATE XIX. *Scale 16 Feet to 1 Inch.*

Fig. 1. Exhibits the Plan of the northerly Pier of the Center Arch, standing on the thorough Foundation, which is laid over with large Stones, Hough and Ham, and some pitched upon their Ends, and all of them wrought close and carefully bedded in Mortar, and the whole covered with a plentiful Coat of dry Grout, and that covered with a thick Bed of sharp Gravel, to preserve the Mortar till it Cements; on the Extremities of which, you see Part of the two Rows of dovetailed Piles which are drove down to the Rock, and cut off at the Surface of the Foundation, which is four Feet and a half under the Low-water Mark, as mentioned before in the Explanations of Plates XIII and XIV.

Fig. 2. Shews the Center Arch, and half of each of the next adjoining Arches, compleatly finished, wherein note, A. The Rock in that Part of the River. B. Part of the natural Bed of the River. C. Thorough Foundation quite a-cross the River, built as above and before-mentioned. D. Five Rows of Oak Piles drove down to the Rock, with a Grating of Timber on them, and wrought into the Masonry. E. The like Grating of Timber under the southerly Pier. F. Low, and G. High-water Marks.

Fig. 3. This Figure represents Part of the Superstructure, which extends 51 Feet from out to out of the Plinth of the Ballustrade. The Foot-ways are 8 Feet each, and the Carriage-way 31 Feet. This,

This, according to my original Plan, was to be paved with Fire-stone, in 5 or 6 Inch Courses, each Course to be scabbled or rough punched at about 1 Inch or 1½ Inch convex, so that the Feet of the draught Horses might take a firm hold of them; and these Courses were to be from 18 Inches to about 2 Feet in Depth, and set with good close Joints in swimming Beds of good Mortar, and for this purpose I took Care to leave a proper Depth on the crown of the Center Arch. And now I hope that what I have offered concerning this Bridge fully expresses every Thing necessary for you to know concerning it.

Tho' the intended Brevity of this Work obliges me to be as concise as possible, yet I think, I ought to embrace this Opportunity to relate a particular Incident that lately happened at this Bridge; but I must first recommend it to you to recollect the covering I had laid on this thorough Foundation between the Piers, as mentioned in the latter End of the explanatory Notes on Plate XV.

This last Winter has been very remarkable for exceeding high Land-floods in this River, but particularly one that came suddenly down from the Mountains on the last Day of *January*, 1775, with such Violence, that it broke the Moorings, and carried off eight Gabbards from the *Coal-quay*; five of them were stopped for some Days by *Essex-bridge*, and three of them carried directly down the River; one of these five lodged against the Sterlings of the middle Piers, and the Flood continuing very violent ten succeeding Days, it was quite impracticable to get her off.

As my young Reader may, perhaps, not be acquainted with the natural Effects of such an Obstruction, it is necessary to observe, that Shoals or Sharps in navigable Rivers, have frequently been deepened and carried off by lodging loaded Gabbards quite a-cross them, because they stop the Current at the Surface, and press powerfully on the Water at the Bottom, which consequently increase the Strength and Velocity thereof, and so break up and carry off the Bed of the River in such Places.

But I shall give a recent and more familiar Instance: About ten Years ago, a rapid Land-flood broke the Moorings of a Raft of Timber at the Barrack-slip, and carried it down to *Queen's-bridge*, where

where it unluckily lodged quite a-cross the middle Arch. The Piers of this Bridge were built on the Surface of the Bed of the River, as most of the former Bridges were. This Raft of Timber obstructing the Current of the Surface, in like Manner increased the Power of it at the bottom, and within the Space of a few Hours totally demolished the Bridge. But to proceed.

During the ten Days that this Gabbard lodged against the Sterlings of the middle Piers, I felt not the least Perturbation, but on the contrary I found my Heart exult with inexpressible Pleasure, being thoroughly convinced, that if all the Arches were stopped up in like Manner for many successive Years, that they would have no more effect on that Foundation than if it had been a solid Rock: However, after the Flood had fallen, Curiosity induced me to examine the Effects of it, and I really was surprized to find, that even the first Foot Stratum of the covering which we laid over the Foundation was not in the least Degree molested. Indeed, the upper Parts of the covering were by that and former Floods mostly washed away, but not stripped of it intirely in any Place, and even if it was all washed away, yet the Mortar on the Surface of it is by this Time so effectually cemented, that the Current passing over it could not make the least Impression on it; and the red Firr dovetailed Piles that case and inclose it down to the Rock (being in Water) will most assuredly last firm and sound for numerous Generations to come; and in the Interval, the Masonry will in reasonable Time cement to such a Degree, as if the Mortar and Grout of the whole were actually petrified, and even so, as to put it out of the Power of Time to destroy it.

For these Reasons I most earnestly recommend it to you, to do all in your Power to make thorough Foundations in like Manner, quite a-cross such Rivers as you may happen to be employed in, that you may enjoy the like tranquil State of Mind, during the remainder of your Life, which I experienced when I saw the Gabbard lie a-cross that Arch.

S E C T. I.

Concerning other necessary Matters relative to the building of Stone-Bridges.

I HAVE now cheerfully communicated a short account of our Proceedings at *Essex-Bridge*, and mentioned every Thing I thought materially necessary for the young Student in the Art of Bridge-building to know, of which, the principal is the Use and Construction of Coffe-dams; and I am sure he may by this Time form a clear Notion of their Utility in Works of this Nature, nor can I conceive the least Idea of any other Way to lay such substantial and thorough Foundations as may be done by their Means.

I must indeed, confess, that the building of the Bridge, was attended with a great deal of Labour Night and Day, for upwards of two Years and a half successively, but that was chiefly owing to the Foulness and Looseness of the Ground, which would not have been the Case, had we been working on clean and fresh Maiden Ground, for on such, there would be but few Difficulties to encounter with; and therefore, to prevent your being discouraged, I must remind you again, that Mr. *Labely* was quite mistaken in his Calculation (mentioned in Page 31,) for notwithstanding the exceeding great Roughness of our Ground, the Rapidity of the River, and the very great Depth we were obliged to sink, and that the whole Circuit of our Dams was much larger than what he would want for one of his Piers, yet, after we had got our Dams staunch, there did not soak for many Tides successively, (exclusive of the subterraneous Water, mentioned in the 7th Chapter) a single Hogshead of Water into our Pit, notwithstanding its exceeding great Depth; but it is not my Intention to lessen the Reputation which that great Artist has justly established, although to prevent your being discouraged from such undertakings by what he has advanced, and for your further Improvement, I believe, without running the hazard of Censure, I might venture to make some further remarks upon

upon it, but I shall leave that to your own Sagacity, by your comparing what he has *said*, to what we actually *performed*.

When you come to Work upon fresh Maiden Ground (as I mentioned above) you will find no such Difficulties, but will have sure ready Work, even at the Depth we went to at the North End, and probably on such fresh Ground, you need not sink much deeper than about three, four or five Feet under the Bed of the River, unless you intend to lay a thorough Foundation; but if you do not, that will be fully sufficient, provided you drive down such Piles as I have recommended in Plate 15, Fig. 4, all round your Foundation, till they get into firm Ground.

In shallow, fresh Water Rivers, the Difficulties and Expences attending this Manner of working, are quite inconsiderable; but you must always observe, that let the Water be what Depth it will, you proportion the Strength of your Dams to the Depth that you are to sink from the Surface of the high Water. In such Rivers as are under six Feet deep, you may make your Dams very slight, excepting in such Rivers as are subject to sudden Mountain Floods: Recollect what *L. B. Alberti* has left us (see Page 9) which are, I think, the fullest and clearest Directions I have met with, and according to the same Manner which he there directs, I advise you to make your Dams in such Rivers as are under this Depth; but in such Water as is only about a Yard deep, one row of Stakes may answer your purpose, and in shallower Water, Sods may prove sufficient; but be well prepared and extremely expeditious, lest a Land-flood should come upon you, yet, even if it did, the Expence would be but inconsiderable.

There have been several Methods practised by illiterate Country Mafons, who have built good rough Stone Bridges over such shallow Rivers as these, and some of them in much deeper Water. I shall mention a few of their Methods; such as, 1st, *Kesh-work*, that is, a kind of large Baskets, made of the Boughs and Branches of Trees, about the size of four or five Feet Square; these they sink in rows, by throwing Stones promiscuously into them till they ground, and then filling them up till the Water is about Knee-deep, whereon they lay Timber a-crofs, and so begin to build their Piers,

banking the Kishes all round with other Stones and hard Stuff thrown in, in like Manner. 2d, *Keeve-work*, that is, making large Vessels of red Deal Boards, hooped both with Iron and strong Oak Hoops, which they fill and sink in like Manner, filling the Vacancies between the Circles, and banking them round with the like rude Stones, &c. 3d, *Chest-work*, i. e. making large Chests of 5 or 6 Feet Square of red Fir Plank, dovetailed and clasped with Iron at the Angles, and these they also fill and bank in like Manner, which is generally among such Workmen deemed a good Method, because they lie so very contiguous to one another, and are very durable. 4th, *Cafe-work*, which is of the same Nature, only much larger and stronger, some of them being 12 or 15 Feet Square, and filled and banked after the same Manner. The 5th, is generally made use of by eminent Workmen in much larger Works. They call it *Cafe-work*, the *French CAISSON*. They are made of large Timber, proportionable to the intended Use, and in Bridge-building, will admit of the whole Pier being built within them. Their bottom is a Grating of strong Timber, and their Sides of square Scantling and thick Planks, which are to be disengaged from the bottom, when the Pier is built within them to above the low Water mark, and then they are to be made use of for the next Pier. They are made perfectly staunch, and a Pit is drudged in the Bed of the River, as deep as they think sufficient, wherein the Weight of the Work sinks these Cafes. All which Methods and several others, I most minutely considered before I designed *Essex-bridge*, and found that none of them would answer my purpose; but having carefully preserved my Remarks, Plans and Sketches on those various Methods, and at innumerable Times since digested them most accurately, and also improved the Observations I made on the Petrifications before mentioned; I apprehended and endeavoured to contrive some others, which I presume among us, may be called *new* Methods, which probably may prove more effectual in most Cafes than any of them, which I have designed to answer either in fresh or salt Water of very considerable Depths, and which I shall reserve for the Subject of the second Part of this little Work.

I am

I am fully convinced, that the Society of Artists that have been lately established in *Dublin*, through the generous Assistance of the *Dublin Society*, has already proved of infinite Service in this Kingdom; and that such a noble Establishment cannot fail in Time, to produce very ingenious and useful Men among us, many having already began to shine forth in different Branches of Science, and particularly in Architecture. This, I think, incontestibly proves that the People of this Country, have as good natural Abilities as those of any other, and were they to meet with equal Encouragement, there can be no Doubt, but they would carry the Sciences and the Arts to as great a Perfection; Encouragement being the kindly Sunshine, which expands the budding Flowers, and makes them produce much good Fruit.

The Guild of Merchants, as an Encouragement to that Society, most generously paid 50 *l.* for the best, 30 *l.* for the second best, and 20 *l.* for the third best Design for the *Royal Exchange*: And the Corporation of this City followed their laudable Example, in procuring Designs for the *Blue-coat Hospital*. And there is no Doubt but when *Ormond-bridge* has fallen down, but they will continue to exercise the same most useful Generosity, and perhaps, much enlarge those Sums, as the Nature of that extraordinary kind of Work, and the prescribing proper and effectual Methods for laying the Foundations in particular, require a great deal of Labour, and justly merit a very liberal Compensation.

In Hopes that many young Students in Architecture, may not only become Candidates, but actually merit the highest Prize, I intend freely and fully to furnish them with proper Instructions for that purpose, to the best of my Knowledge, but chiefly with respect to the Foundation, and the principal Lines suitable to that Bridge; but in order to exercise their own Ingenuity, I shall leave the Decorations to themselves.

I have shewn what a loss I was at, and what infinite Trouble I had to find out and procure effectual Methods to lay the Foundation of *Essex-bridge*. I have given a succinct Narrative of the whole of my Proceedings in that Work. I also set forth the good Fortune I had in getting Colonel *Belidor's* Method of making
Coffer-

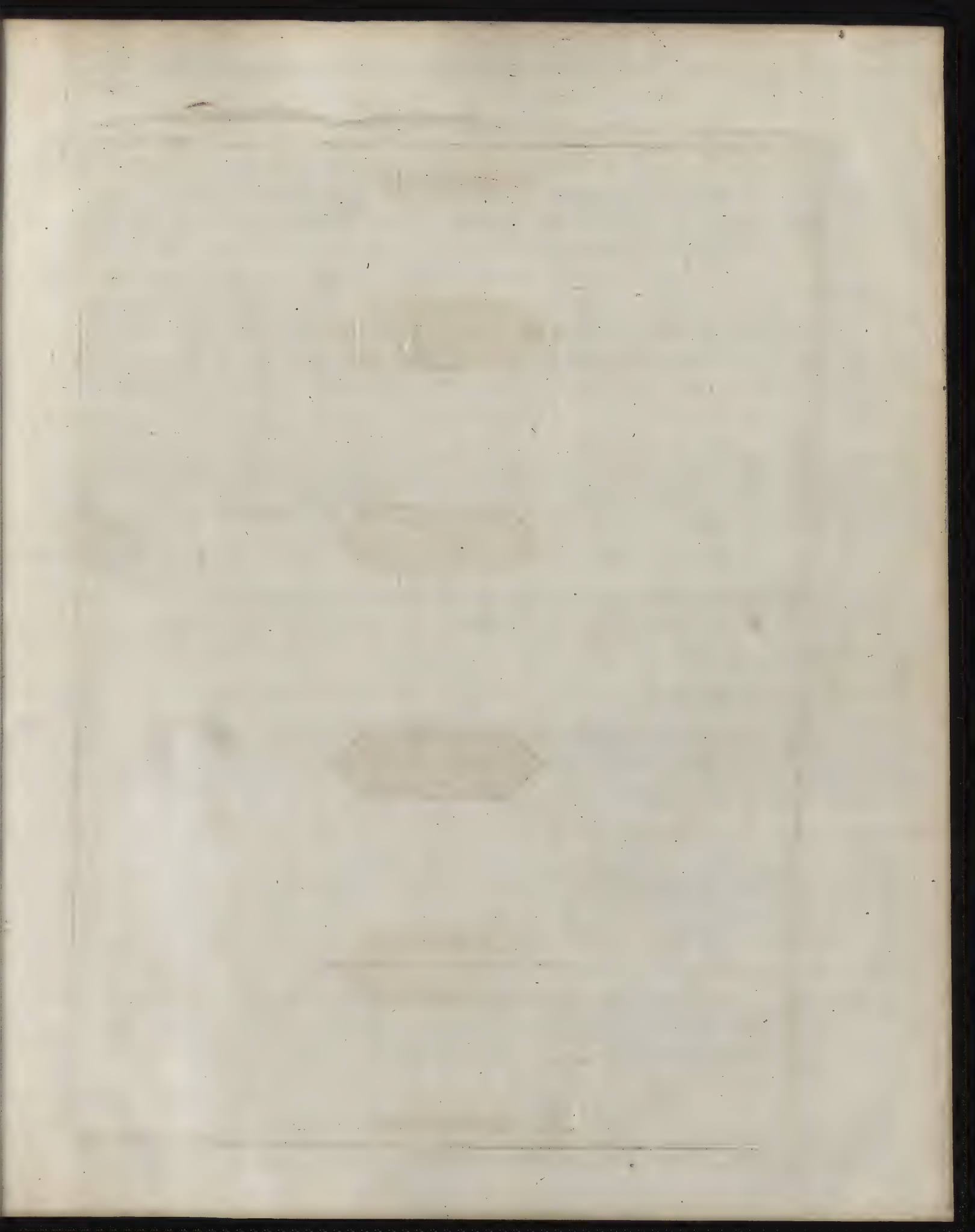
Coffer-dams, in the very critical Time I wanted it, for I had every Thing else to invent, to contrive and to reduce into order. The whole of these several Particulars you have now before you, and on a thorough grounded Knowledge I assure you, that the various Circumstances relative to the re-building of *Essex-bridge* that is done, and *Ormond-bridge* that must soon be done, are exactly similar to one another, excepting, indeed, that the latter will be much less in size, and not near so troublesome nor expensive as the former; but I am very certain, there is no other Method to accomplish it than that by which I completed the other. The whole of what relates to the first, and all that is necessary for the latter, you have also now before you ready at Hand, without giving you the least Trouble to contrive or invent any Thing. And I hope my young Countrymen will now exert themselves, and use their utmost Endeavours to make themselves Masters of the Art of Bridge-building, and not lay the Corporation of the City, or other Gentlemen under a Necessity of procuring Artists from other Countries, when they have, or may have as fit Persons for their Purposes at home.

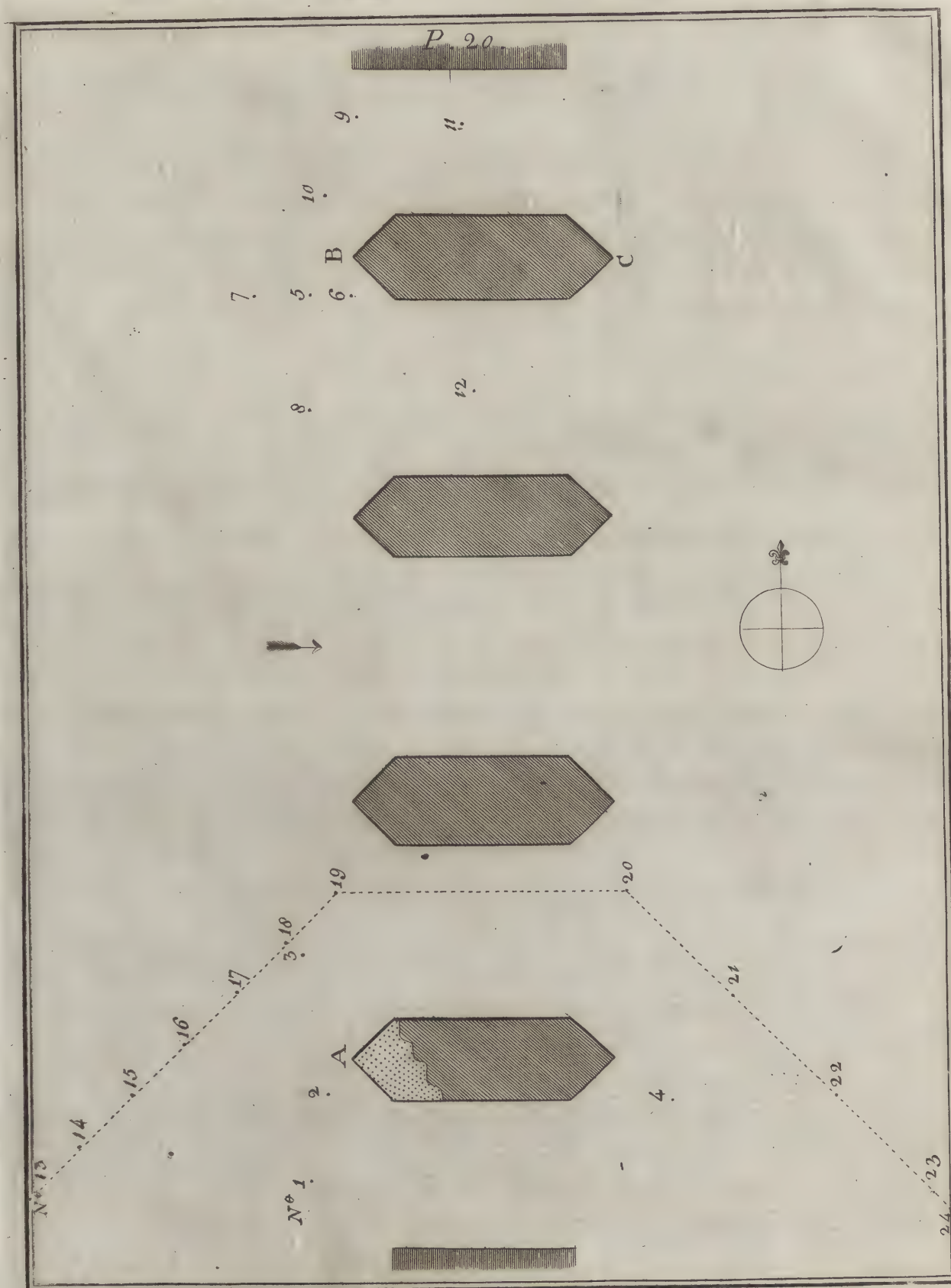
C H A P. XI.

Concerning ORMOND-BRIDGE, with the Soundings and Borings adjacent, and Remarks on the Bed of the River.

IN the Year 1682, Sir *Humphrey Jervis* built a Bridge of Timber in this Place, which stood but two Years, which was, probably, partly owing to the injudicious Construction of it, or more probably to the intolerable softness of the Ground it was built upon; but be that as it may, in the Year 1684, the Corporation of the City began to build the present Bridge. See Plate XX. Scale 20 Feet, 1 Inch.

In *April* 1752, this Bridge was in the utmost Danger of sharing the same Fate that *Essex-bridge* had so lately met with; on which my Brother *John* and I were ordered to go and examine it, which accordingly we did, and we found that the South Pier at A, had greatly failed: The Bed of the River on which it stood was washed
away,





away, and the first Course of the Stone-work also, for about seven Feet under the Pier, and Part of the second Course, and that *that* Part of the Pier had no support, but the Strength of the Mortar and the bond of the Work.

This Discovery induced us to examine the true Cause thereof, in order to determine on the Methods for repairing it, which we could not effectually do without boring the Bed of the River, to find out what sort of Ground it was built on; and having at that Time made some correct Soundings and Borings, and otherwise very strictly examined it, and having now the Drafts, Soundings and Borings thereof by me, I do apprehend, that within some very short Time, it must inevitably fall; and as I am now so healthful as to be able to reconsider them, it may be of use to the Public in general, and to the Corporation of this Hon. City in particular, to form such a Design for the rebuilding of the same, as shall appear the most eligible.

For this Purpose I here give the Public the true Soundings and Borings, so far as we at that Time took them; wherein note, That the Dots under the Numbers of the first 12, and opposite to the other 12 Borings, are the Spots into which we bored. Our high Water mark at *Essex-bridge* (See Plate XIX. Fig. 2. G.) was transferred by the level of the Water to this Place, allowing the same ten Feet from low to high Water, although, in Fact, it is not just the same, because the Bed of the River rises higher the further one goes up it.

B O R I N G S.

N ^o	Feet.	Inches.	
1	9	8	From high Water mark to the Bed of the River, S. Side.
	8	0	Coarse, loose Sand or Gravel.
	8	3	Soft blue sandy Loam.
	25	11	Rock.
2	12	6	To the Bed of the River.
	3	0	Coarse, loose Gravel.
	10	3	Of soft, sandy, blue Clay or Loam.
	25	9	Rock.

N^o.

N ^o .	Feet.	Inches.	
3	9	11	To the Bed.
	6	3	Harder and coarser Sand.
	7	5	Soft blue Clay or Loam.
	23	7	Rock.
4	15	0	To the Bed.
	6	5	Coarse, gravelly Sand.
	8	0	Soft blue Clay or Loam.
	29	5	Rock.
5	10	3	To the Bed, (North Side)
	11	6	Soft blue, sandy Clay or Loam.
	21	9	Rock.
6	9	11	To the Bed.
	9	7	Exceeding soft, sandy Clay or Loam.
	19	6	Rock.
7	10	2	To the Bed.
	9	7	Exceeding soft, blue Clay, or rather Mud.
	19	9	Rock.
8	11	4	To the Bed.
	10	0	Very soft blue Clay, or rather Mud.
	21	4	Rock.
9	10	1	To the Bed.
	8	2	Exceeding soft blue Clay, or Mud.
	18	3	Rock.
10	9	2	To the Bed.
	8	2	Exceeding soft Loam, or Mud.
	17	4	Rock.
11	0	0	To the Bed.
	8	7	Exceeding soft Mud. <i>N. B.</i> The Men found this so soft, that they thrust down the Rods in a Minute without boring, and they believed they could do the same with a ten Foot Rod, after they were through the upper Crust of Sand and Rubbish.
	18	7	Rock.

N ^o .	Feet.	Inches.	
12	11	6	To the Bed.
	10	2	More stiff and coarser.
	21	8	Rock.

The dotted Line which incloses the South Pier, is the outward bounds of the Coffe-dam, which we made to keep off the Water, till we under-pinned that West End of it, where we found that there was nothing supporting the upper Work, but the Bond of the Stones, and the Strength of the Mortar as before-mentioned, for that Pier had not a Frame of Wood planked in the bottom, under nor round it, as the Piers of *Essex-bridge* had, but the bottom Course of it was laid on the naked Bed of the River, as I believe all the rest of the Piers are. Some of them have sunk to the Eastward, and some of them, but particularly the North Pier, to the Westward, one Foot nine Inches at B. more than at C. and greatly dislocated that Arch, which I believe has been rebuilt, for by the Courses of the Stones in the Piers, it is evident that no Arch could possibly stand, when one End of the Pier had settled so much more than the other, and considering all these Borings together, it is somewhat surprizing it has stood so long.

The large Dotts in the dotted Line, were taken in order to know the different Depths of the Water, whence to calculate the Length of the Piles for the Dam; but they also are of some use now, in giving us the Depths of the Water from high Water mark, in those several Places, viz.

N ^o .	Depth.		N ^o .	Depth.	
	Feet.	Inches.		Feet.	Inches.
13	5	3	19	11	3
14	5	9	20	12	1
15	8	5	21	20	0
16	11	9	22	20	0
17	12	9	23	13	3
18	12	3	24	9	3

K

Remarks

Remarks on the Bed of the River, &c.

Although we only pierced the Bed of the River in 24 Places, yet that was fully sufficient for our Purpose, and indeed, I think, they are also pretty sufficient for my present Consideration, upon which I can safely conclude, that the Ground opposite *Charles-street*, (where the Bridge must be built) is not able to support the Weight of a Bridge; and if you turn back and re-examine the Borings of N^o. 5, 6, 7, 8, 9, 10 and 11, you will coincide in Opinion with me; but I do not by any Means advise you to depend entirely on these Borings, but take a Carpenter with you at low Water, and let him bring a Hand-spike pointed at one End with him, and a nine Foot Pantile-lath or a Quarter-four, and let him break through the Crust of the Ground, by first driving or working down the Hand-spike 2 or 3 Feet, and I will venture to engage, that he can thrust down the Pantile-lath to the Rock, in any Place you please to fix on thereabouts, especially at 9, 10 and 11; nor need you have any other Implements to prove the most Part of our Borings; and these Experiments will be of Use, and give you a true Idea of the Nature of the Ground you are going to build upon; and that will also partly discover the Reason that the Wooden-bridge before-mentioned, lasted but two Years, and excite your Admiration, that the present Bridge has stood so long, without suffering the same Fate. I shall now lay before you the principal Lines of my Design of a Bridge suitable to that Place, and effectual Methods for the Accomplishment of it.

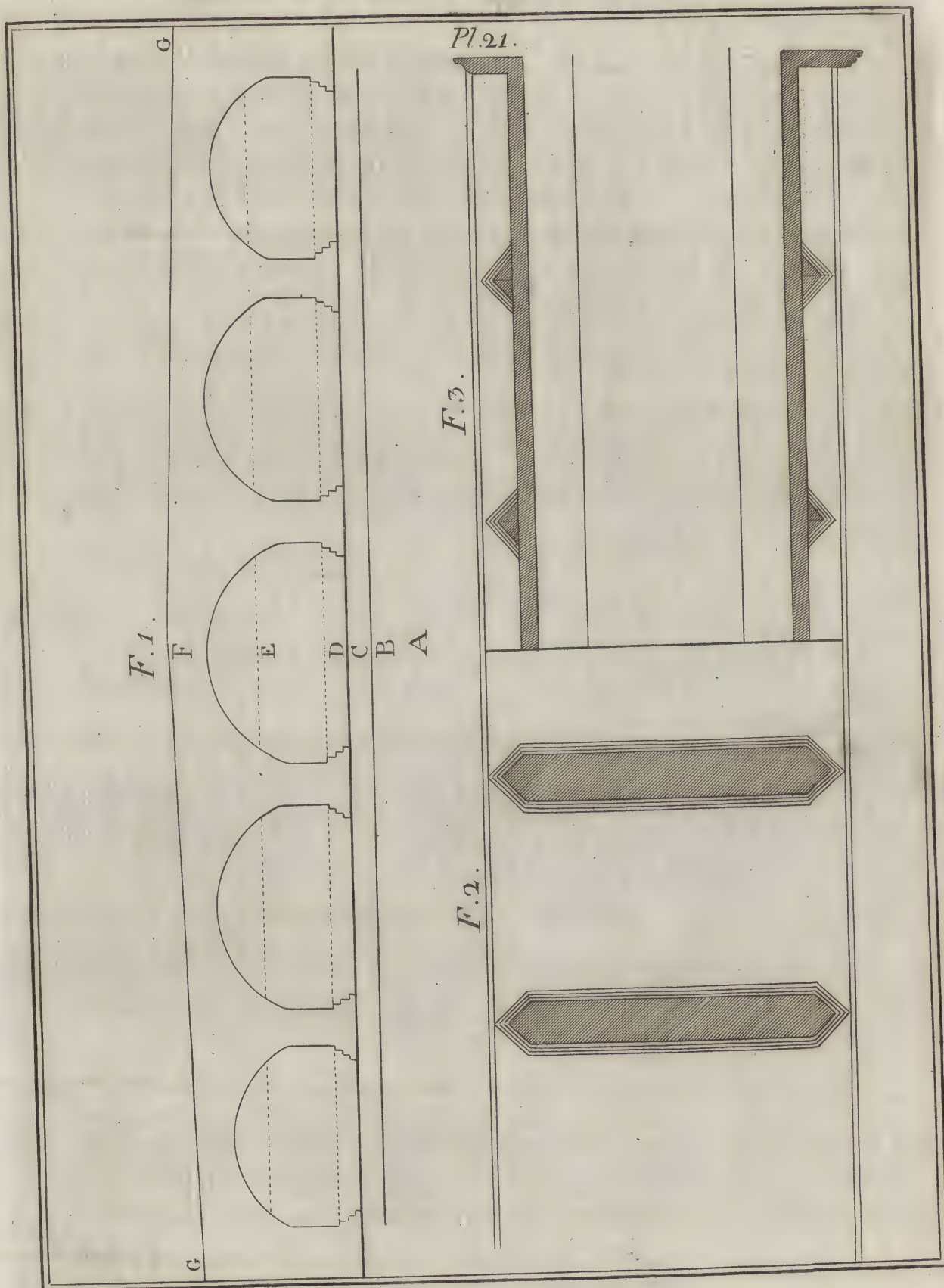
C H A P. XII.

The principal Lines of a Design for ORMOND-BRIDGE, with proper Instructions for the Execution thereof.

EXPLANATION of PLATE XXI. Scale 20 Feet 1 Inch.
Fig. 1.

NOTE, A. The Rock, (supposed upon an Average to be about 12 Feet under low Water mark). B. Part of the natural
natural





natural Bed of the River. C. Thorough Foundation of Masonry, (three Feet high). D. Low-water mark (three Feet above ditto. Foundation). E. High-water mark, (taken at 10 Feet on an Average). F. Pavement, (five Feet from the Soffeto of the Center Arch). From low Water mark to the spring of the Arch is 6 Feet. Thence to the Soffeto of the Arch 10 Feet 4 Inches, and F. 5 Feet: In all 21 Feet 4 Inches. G. G. Pavement 19 Feet. Declivity 2 Feet 4 Inches in the Pavement from F to G.

It may not be amiss here to observe, that a great deal depends on a judicious erecting of the Sounding-boards. Try the Depth at several Ebbs, observing that it is much more advisable to calculate from the lowest Ebb, for fear of raising the Summit of the Pavement too high, and be sure that all these Dimensions agree together from your low Water mark. The next material Thing is to consider the Water-ways.

The Voids and Solids, or the Piers and Arches of the present Bridge, and of this Design compared.

Present Bridge.					This Design.						
Plate XX.		Ft.	Inch.	Ft.	Inch.	Plate XXI.		Ft.	Inch.	Ft.	Inch.
South Arch	-	20	0	0	0	South Arch	-	25	6	0	0
South Pier	-	0	0	11	3	South Pier	-	0	0	5	6
2d Southerly Arch	-	24	3	0	0	2d Southerly Arch	-	28	6	0	0
Ditto. Pier	-	0	0	11	10	Ditto. Pier	-	0	0	6	0
Center Arch	-	27	8	0	0	Center Arch	-	31	0	0	0
3d Pier	-	0	0	11	0	3d Pier	-	0	0	6	0
4th Arch	-	25	2	0	0	4th Arch	-	28	6	0	0
4th Pier	-	0	0	10	11	4th Pier	-	0	0	5	6
5th or North Arch		20	0	0	0	5th or North Arch		25	6	0	0
Total		117.	1	45	0	Total		139	0	23	0

N. B. Abutments 10 Feet each.

In fixing upon the Scite of this Design, observe that the middle of the Bridge must be opposite to the middle of *Charles-street*, but not in direct Line with it, because the River and the Street form an acute Angle, and the Bridge must be on right Angles with the Current, otherwise the Piers will incline athwart the Stream, which

always ought to be avoided, as far as other Circumstances may reasonably admit of it.

Fig. 2. Shews the Plans of the two southerly Piers, and the Inclosure of the thorough Foundation, which must at the least be 50 Feet broad in the clear of the Piles that inclose it. Fig. 3. Shews what the Superstructure will be when finished.

EXPLANATION of PLATE XXII. *Scale 30 Feet 1 Inch.*

This Plate represents the first general Plan of Operation in laying the southerly Foundations; wherein note. A. Pool for Pump Engine. B. B. Water Trunks. C. The Pit for building the South Abutment and Pier. D. Pit for building the 2d South Pier, &c.

EXPLANATION of PLATE XXIII. *Scale 5 Feet 1 Inch.*

Fig. 1. Plan of the middle Dike of the Cofferdam, through the Center Arch.

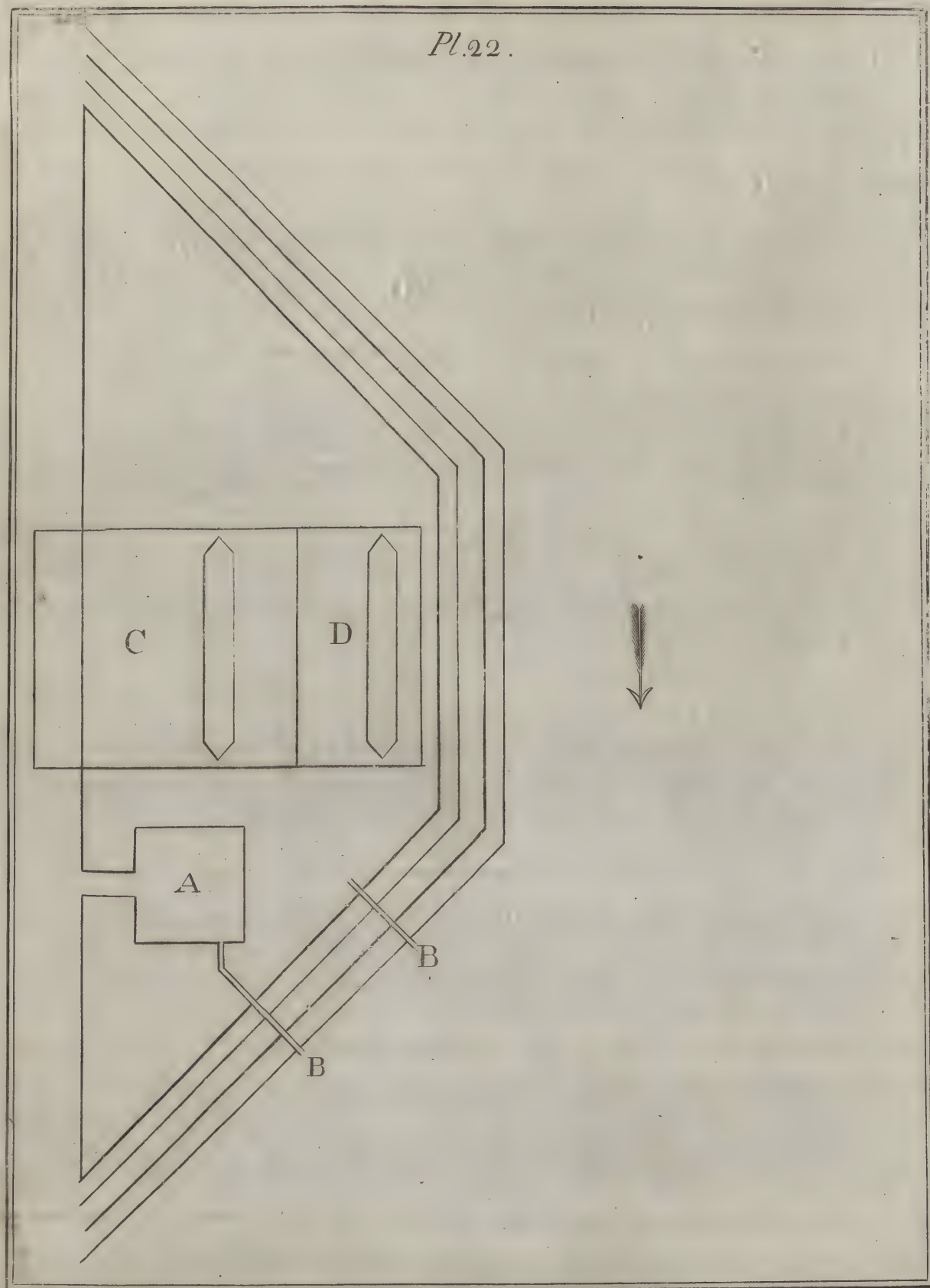
Fig. 2. Construction of the Cofferdam, wherein note. A. Low-water. B. High-water. N. B. After the Frames are drove down as deep as you can drive them, they are to be strained together, so as to give them a six Inch batter in the middle row, and the outward Rows in the same proportion as formerly directed.

Considering the exceeding soft Ground on which this Dam is to be erected, it is very probable, that after the Clay is put in them, they will be liable to incline either to one Side or the other, and whenever you can perceive that, or you observe that the Clay spreads out the middle Frame, in either of these Cases, and either within or without the Dam, you are to proceed after the same Method already fully laid down in Plate VIII. C. e, f, g and h, explained in Page 32.

EXPLANATION of PLATE XXIV. *Scale 5 Feet to 1 Inch.*

Fig. 1. I apprehend, that I have been so explicit on Plate XIII. Fig. 1. that I need not repeat here, as this Draught and Scale may
fully

Pl. 22.





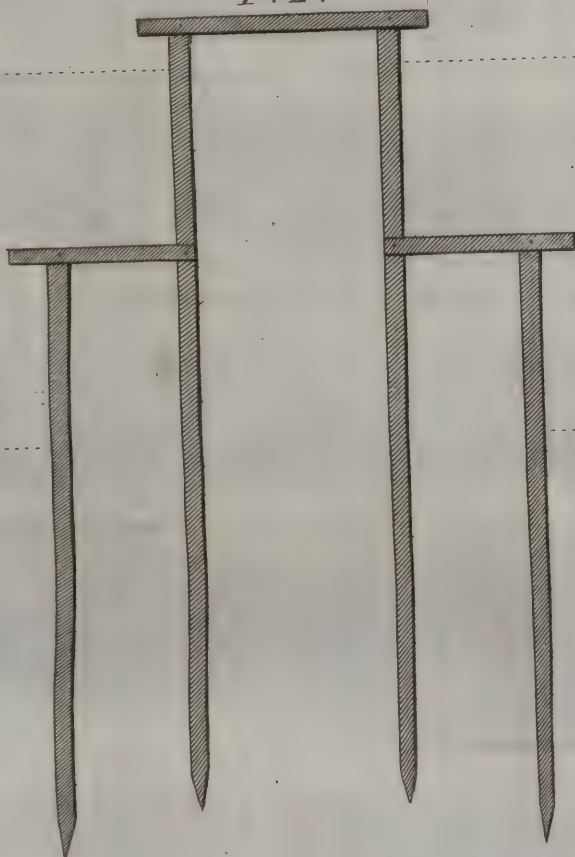
Pl. 23.

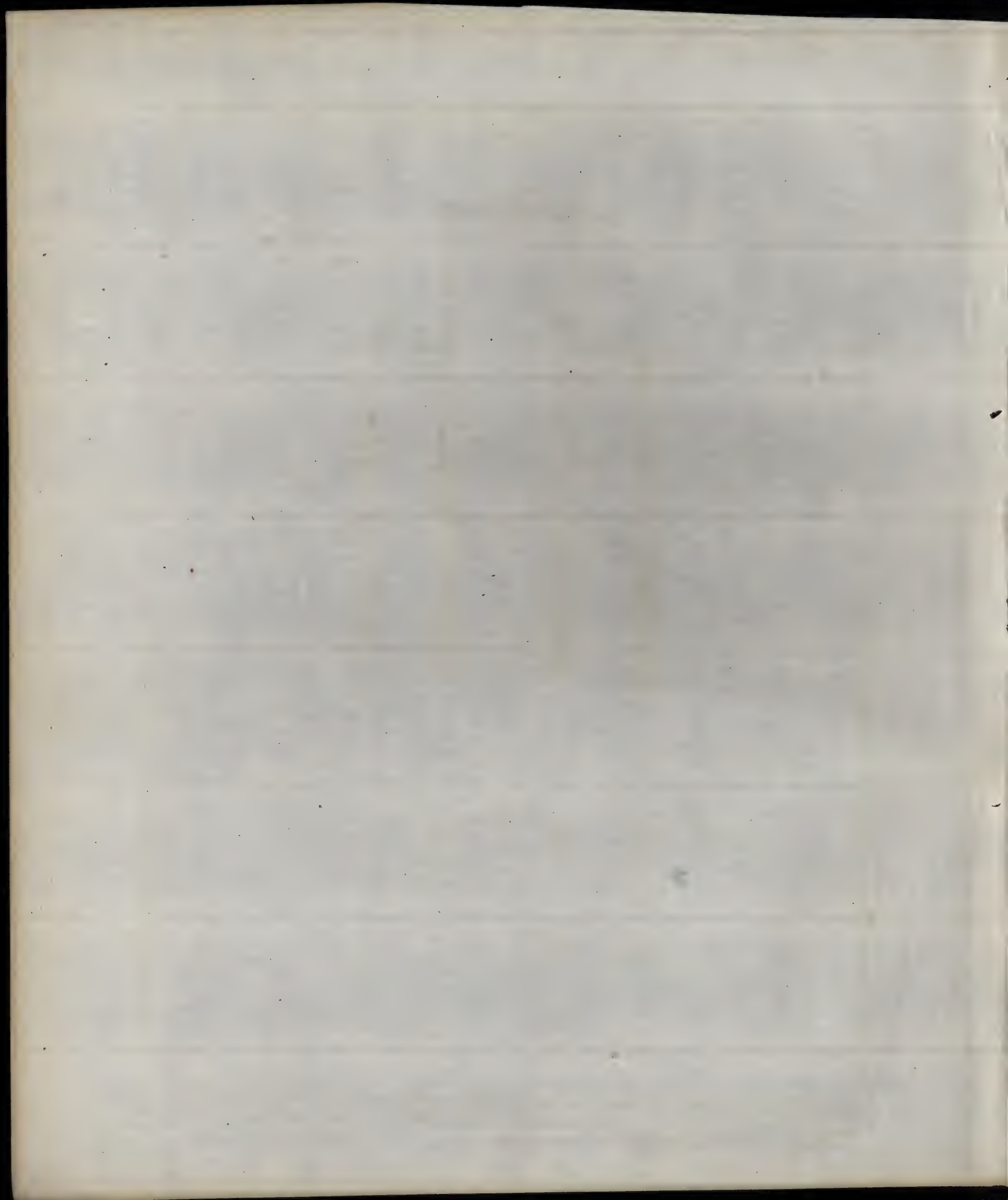
F. 2.

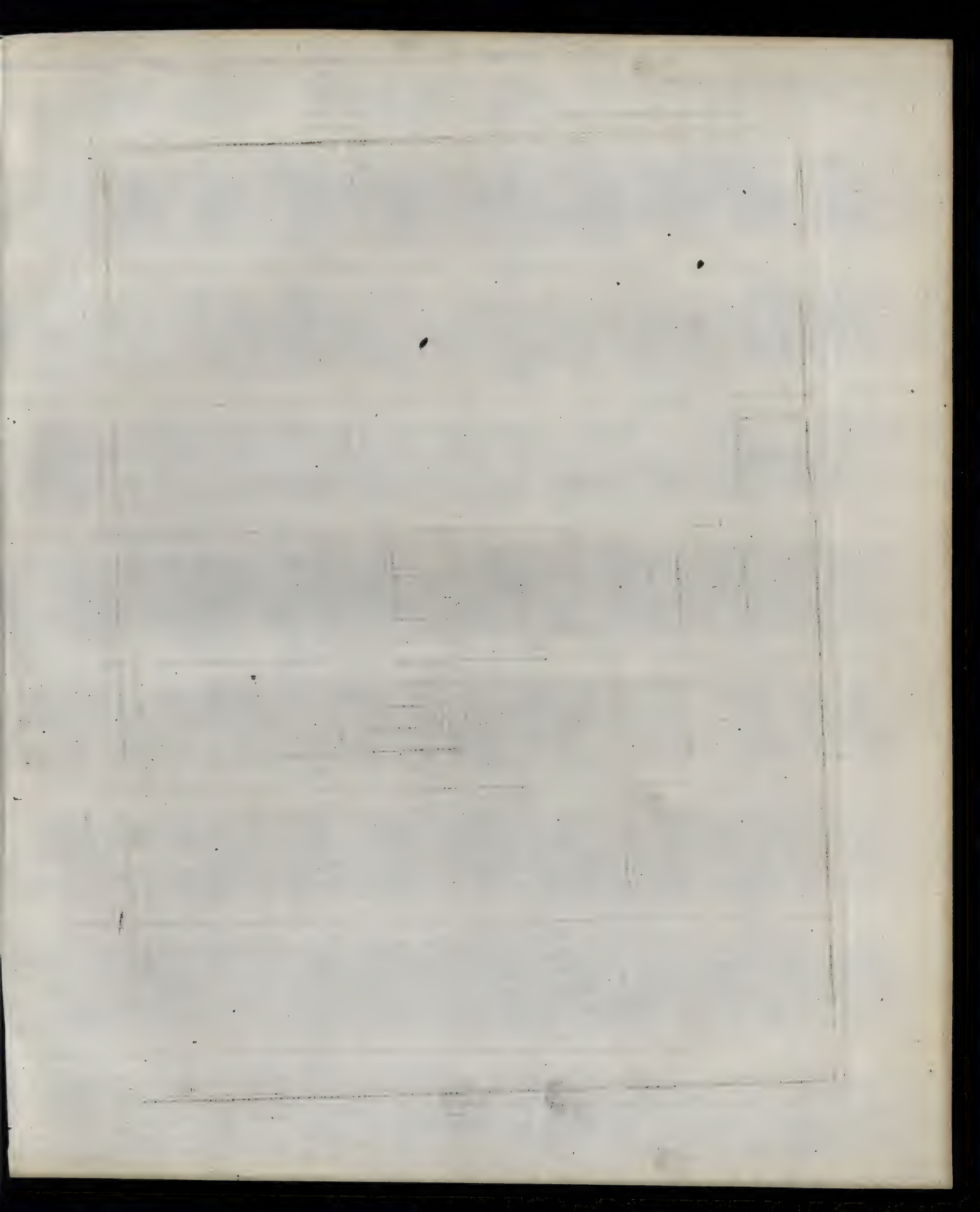
B

A

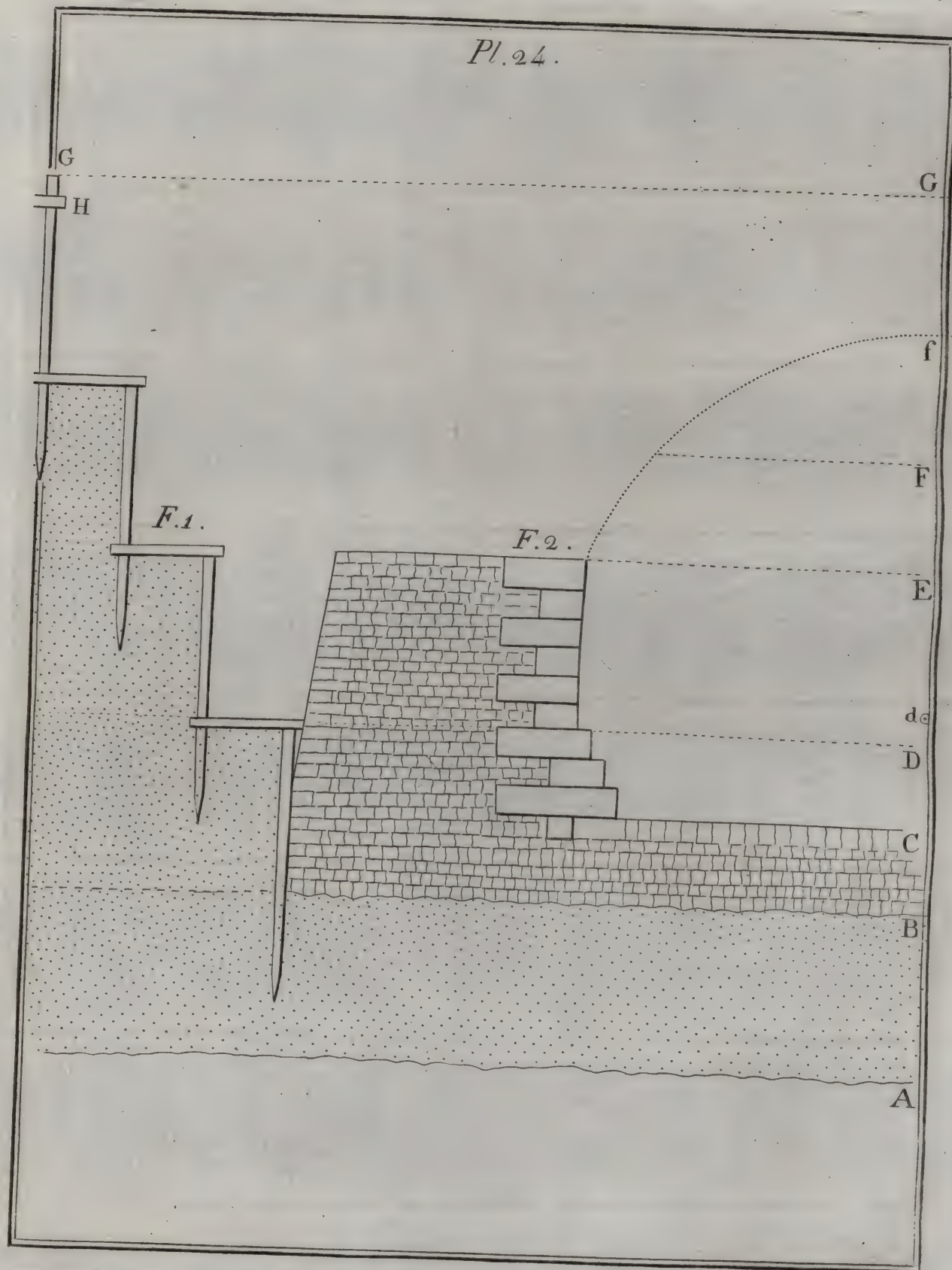
F. 1.



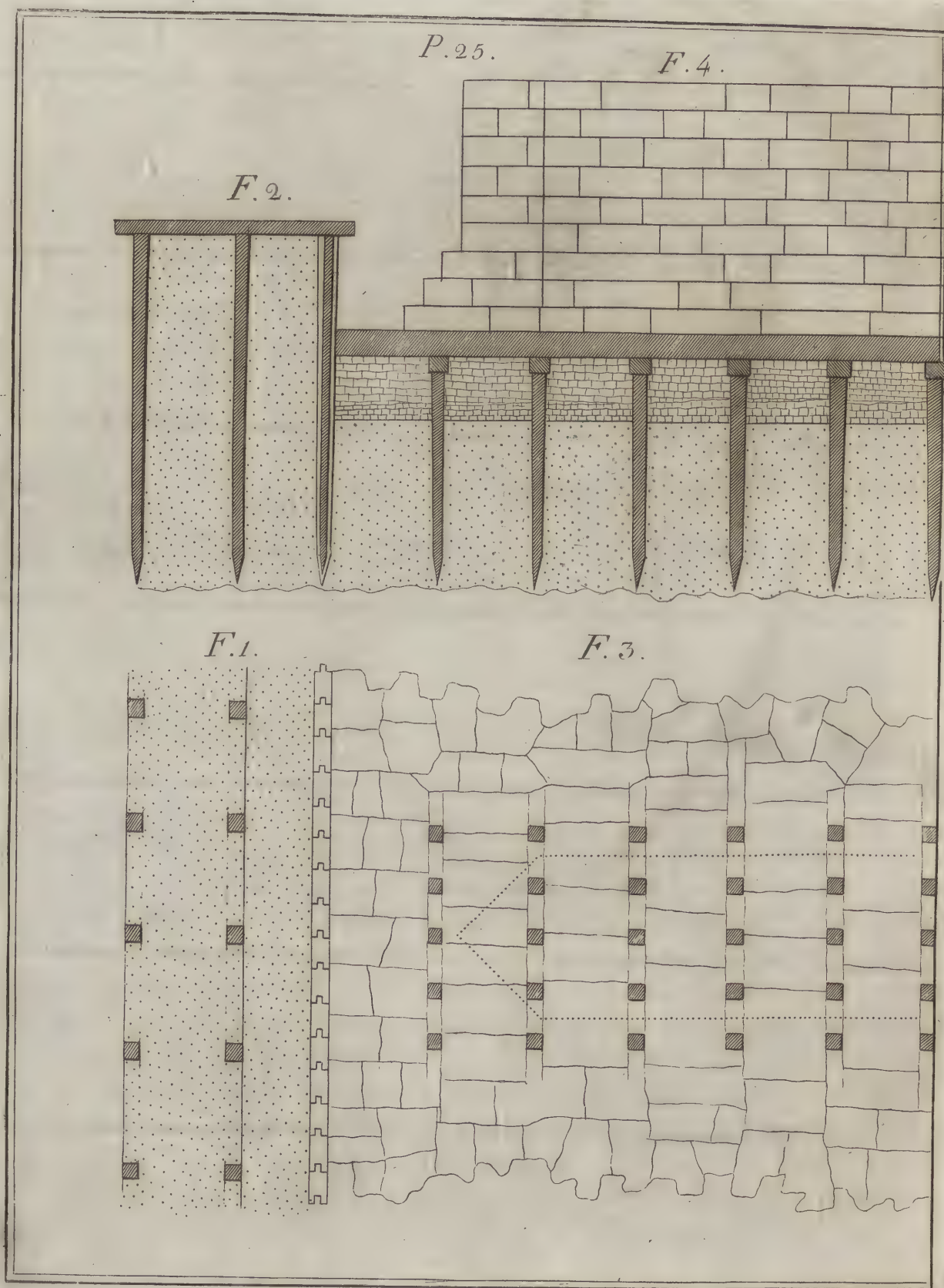




Pl. 24.







fully answer your Purposes; only observe, that G. is the Superficies of the present Pavement, which is 25 Feet from the level of the bottom of the Pit; and if you find it necessary, you may go another Foot deeper. H. Is the End of the Land-tye.

Fig. 2. Section of the Land Abutment and half of the South Arch, wherein note. A. The Rock. B. The bottom of the Pit, (unless you go another Foot deeper, as above-mentioned). C. The Surface of the thorough Foundation, which is here supposed to be three Feet high; but if you add the other Foot in Depth to it, do not forget that Foot afterwards in all your other Dimensions. D. Low-water mark 3 Feet. d. Center from which the Arch was described. E. Springing of the Arch. F. High-water mark. f. Soffet of the Arch which is 8 Feet 6 Inches, that is $\frac{1}{3}$ of the span from E. to f. G. Surface of the Pavement.

EXPLANATION of PLATE XXV. *Scale 5 Feet to 1 Inch.*

West End of South Pier.

Fig. 1. Is the Plan of the Coffin (or Inclosure of the inner Pit) for laying the Foundations. Fig. 2. Is the Section of the same. Fig. 3. Is the Foundation of the West End of the South Pier; wherein observe, that there are five Piles in each row, at about 14 Inches asunder, and about three Feet distance in the rows. In the North Piers of *Essex-bridge* you may observe they were four Feet asunder each Way, because the Ground was there tolerably strong, but here it is intolerably soft, and therefore, it is requisite they should be drove closer; yet we must not depend too much upon the Piles, but endeavour to make the Mason-work as substantial as possible, in order to which, let me recommend the procuring good stout rough Flags scabbled to three Feet long (the Distance of the rows the long Way) and after laying at the least, half a Foot thick of sharp Gravel, covered with two or three Inches thick of Rotten-lime over your Ground, bed those coarse strong Flags upon it, which will fill the three Feet rows from Pile to Pile; then throw in Pieces of Flags, that will fill between the Piles the other Way, and

from thenceforward, let each Stone swim in good strong Mortar, closely and carefully wrought. Another Method may be this: Sink the bottom of your Pit seven Feet under low Water mark, and allow the Foot before-mentioned to be filled with that Bed of sharp Gravel covered with Roach-lime, and then your Masonry will be three Feet as above. The Reasons for this will be hereafter mentioned.

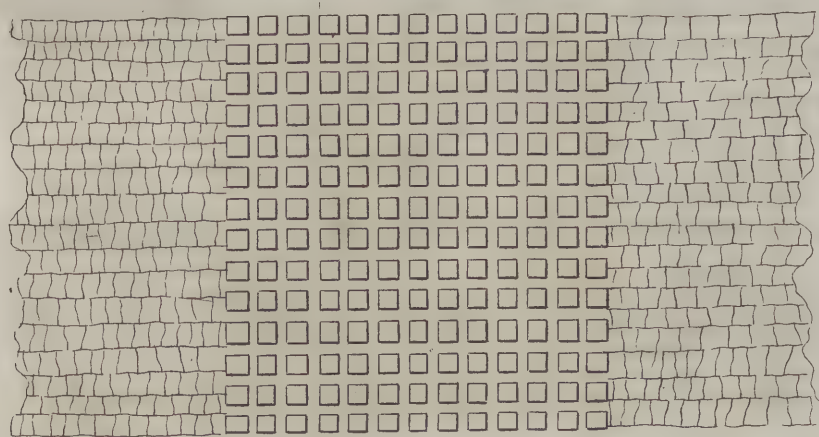
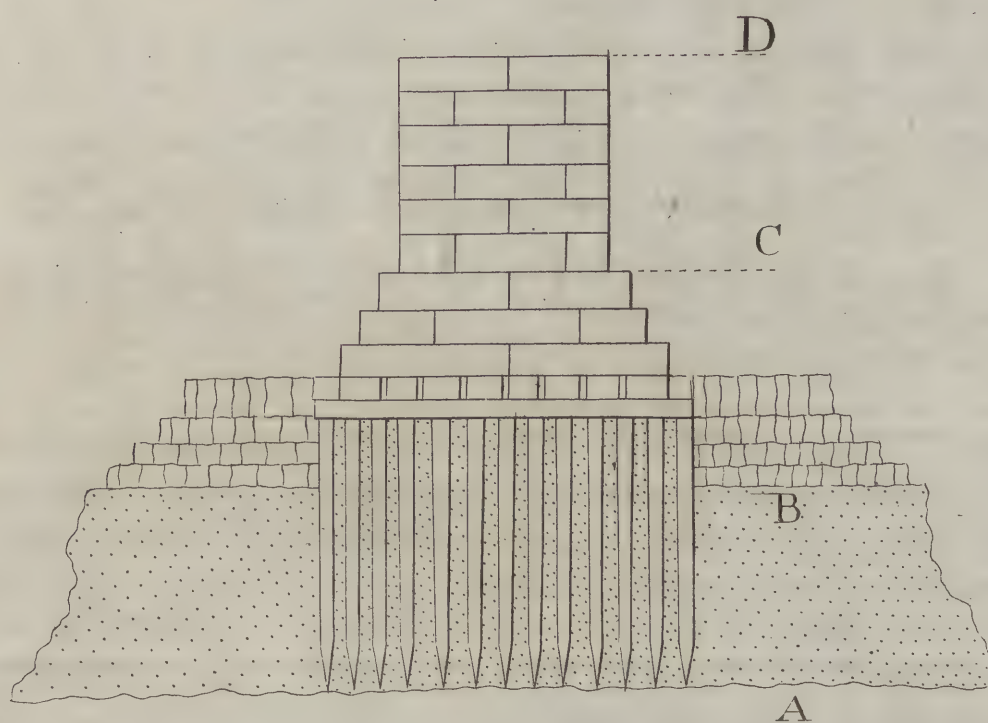
Fig. 4. Is the Section of the West End of the South Pier, and the Foundation on which it is to stand: Observe, to be sure of your Distance from the Rock, before you cut your Piles to their Length, and let them be rather too long than too short, and in driving them (which will be easily done) that every one of them goes down to the Rock: Cut them exactly square and level, so that your Caps may lie firm upon them, and be careful, that your stretching Beams lie firm and solid upon all your Caps. These stretching Beams ought to be 50 Feet long at the least (as before-mentioned) if you can conveniently get such, that they may reach quite across the Foundation: That is, the clear of the dovetail Piles that case and secure it, especially the middle Beam, but the rest may be proportionably shorter; and that the Masonry be made level to the Heads of the Piles, take Care that the Caps may lie solid on them also: And the same Care is to be taken when you are levelling to bed your stretching Beams, and that the Masons do most punctually observe the Directions before given for them. The next Pier is to be done after the same Manner.

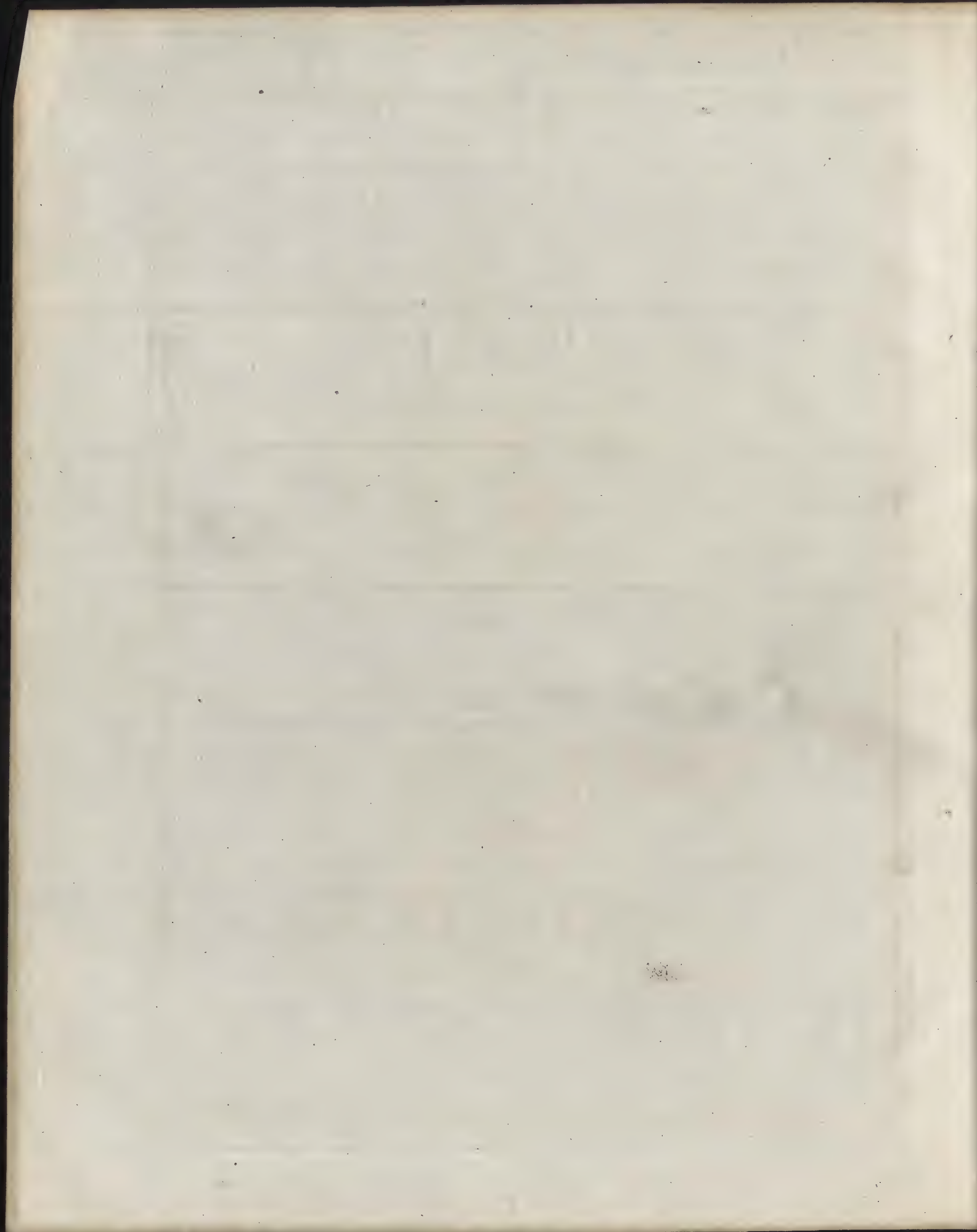
EXPLANATION of PLATE XXVI. Scale 5 Feet 1 Inch.

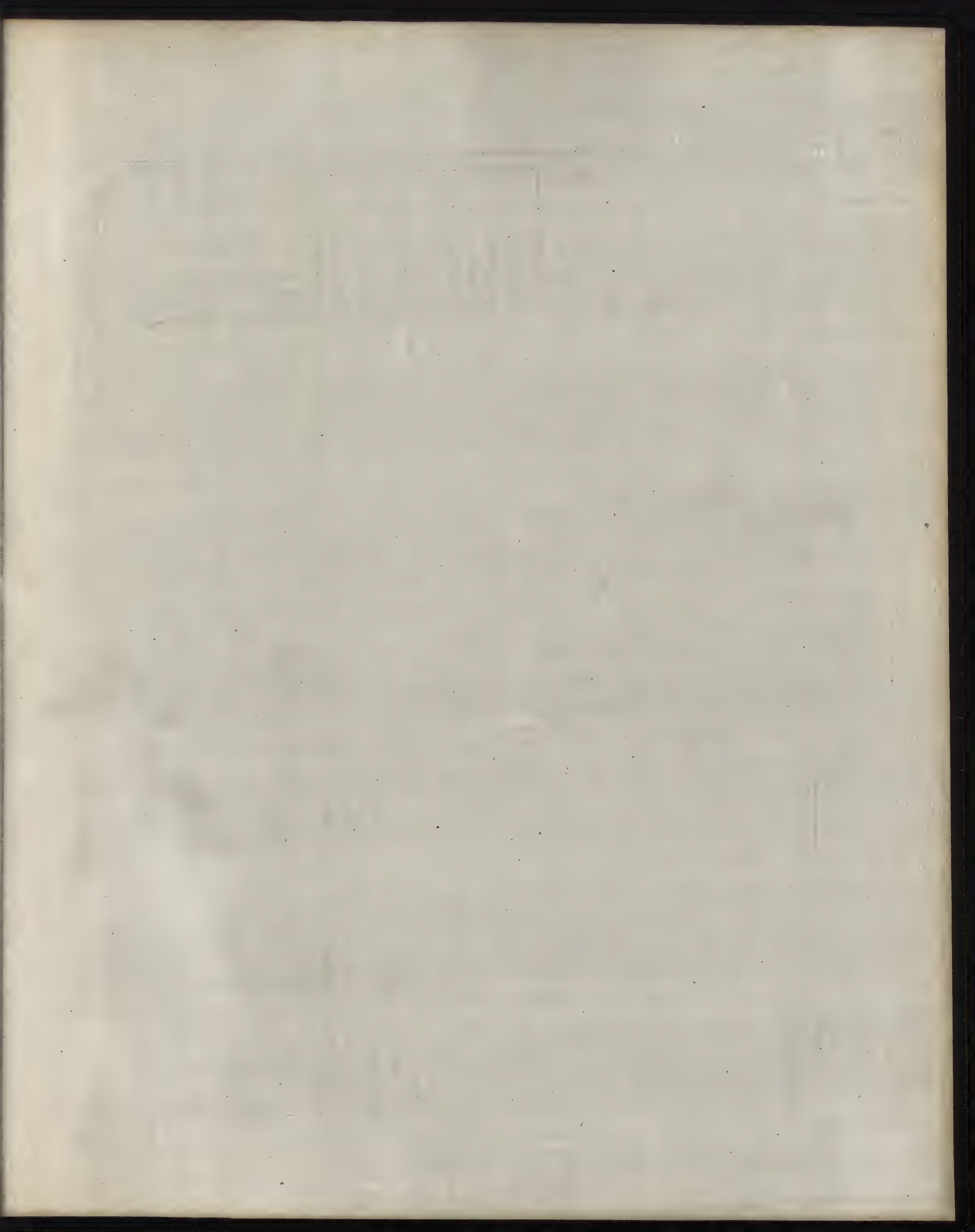
The Plan and Section of the North Pier springing high.

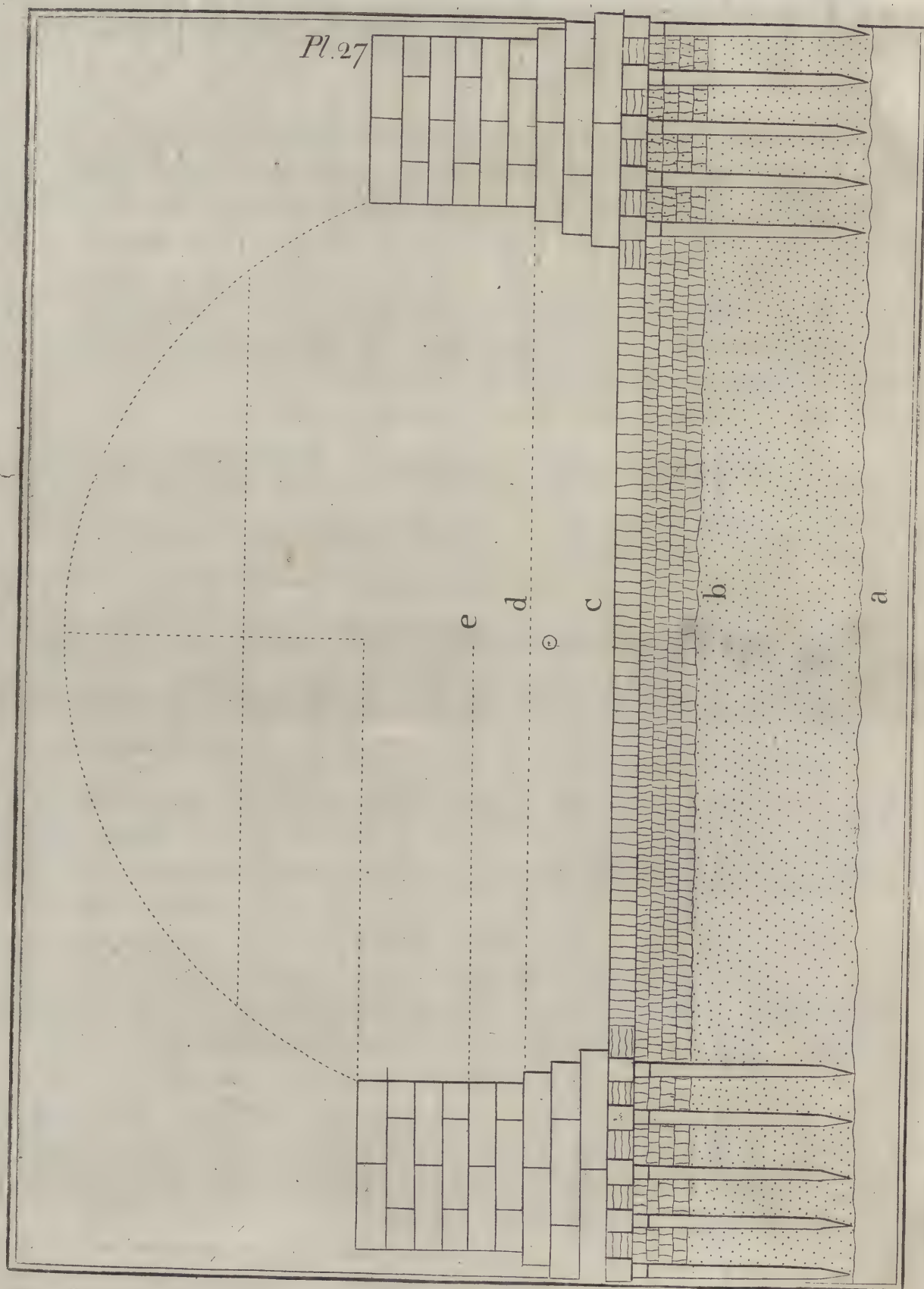
The Bed of the River at this End of the Bridge, being much softer than at the other End, you ought to endeavour to make them both alike strong: In order to which, I propose that this Pier should stand upon Piles. For if you recollect the eleventh boring, I believe you will conclude with me, that notwithstanding all the Care and Cautions given to the rough Masons, their Work between the
rows

Pl. 26.









rows of Piles will be in danger of subsiding, and so that Pier would consequently and principally stand on those single rows of Piles. It must, therefore, certainly be the safest Way to Pile the whole as you see it herein drawn, with the grating of Timber on them. You may observe there is a Supernumerary row of Piles at each Side, lest they should not exactly square with the site of the Pier, and to leave a little set-off for your first projecting Course; the thorough Foundation is to be laid with large well-headed Stones against the Piles, and the Spaces between them to be stuffed full of small Stones, Roach-lime and Gravel, to keep all firm and steady, that they may not lean either to the one Side or the other in that sloughy Ground. Note, A. the Rock. B. Bottom of the Foundation. C. Low-water, and D. springing of the Arch as before.

EXPLANATION of PLATE XXVII. *Scale 5 Feet 1 Inch.*

Section of the thorough Foundation, and the two middle Piers springing high.

I hope what I have already said has been so explicit, that I need not repeat it. If I was to make any Amendments on this, it would be to make the rows of Piles only two Feet asunder instead of three, but that only in this North Pier, as even here, that Pier stands on the softer Ground of these two Piers of this Arch.

I shall now again give some friendly Cautions, that I could wish were deeply imprinted in your Mind as general Rules; that is, never pretend to draw a Design, or engage in any Work of this Nature, without most strictly examining the Strength of the whole Ground that is to support it; and if you find the Ground under any of the Piers, or any Part of them, is not equally strong, that either by piling, or some other effectual Method, you bring the whole upon an Equality, so that your Work may stand firm and secure for Ages to come. If you are to build a Bridge over a navigable River, it might be, that in some former Time Ballast-men might have drudged a Hole, which was immediately filled up with Slough (which I take to be the Cause of the Pier sinking of *Westminster*

minster Bridge) upon which, perhaps, one End of a Pier might stand, or under one End of a Pier there may be a Rock, and under the other soft springy quick Sands or the like; or further, perhaps, you may have a solid Rock on one Side of a River, and very soft Ground on the other, from all which, and many other such Cases, it is indispensably necessary to search diligently into the Bed of the River, at the least, within the full extent of the Ground you intend to occupy: And consider also, how will you be able to answer for your Conduct, in pretending to build a Bridge that for aught you know, may tumble down before it is even finished, or at best may not stand many Years till it begins to totter or lean to one Side or other; and if it is over a navigable River, recollect what I told you before of the Bridge built by *Trajan*, that so totally destroyed the Navigation of that Part of the *Danube*, that they were forced to cut a new Channel for the trading Vessels, to avoid the Ruins of it, which you know cannot be done in any trading Town or City.

We have heard that the finding out the Disease, is one half of the Cure, and there are Remedies for all sorts of Diseases, but the great Art is to discover them; and in the present Case, when you know the Evils you are to guard against, you consequently ought to find out Ways and Means to prevent them. Your Bed of the River we will suppose, in the Condition we have been considering; surely then, there cannot be a more effectual Method to strengthen and bring the Bed to a sufficient Equality, than that which the three eminent Architects have mentioned of turning off the Water, by making an Enclosure or Coffer-dam: In the Execution of which, you will find much Pleasure and Satisfaction, provided you observe this repeated Advice, that is, to spare neither Time nor Trouble to drudge out and remove all the Stones and Rubbish from under the Dikes of your Dams, and if you do so, I can answer for it, that every Thing else may be most effectually executed.

But it is also proper to apprise you, that among the several other Methods that have hitherto been made use of, there is one not yet mentioned, which soft slutchy Ground, perhaps, will move some Persons to recommend, and that is, piling for the Piers, or as Mr. *Labeley* deridingly calls it, building upon Stilts; and you shall now under-

understand the Difference between that Method, and this which I recommend.

The general Method of building Piers of Bridges upon Piles is this: They drive down Piles close together to near low Water, cut them level and square at the Heads, and lay thereon a Grating of Timber, whereon they begin to lay the Cut-stone Work of their Piers, the bottom of which may probably be about two or three Feet above low Water: This is a very tedious Way, because the Tide always interrupts their Proceedings, but in Case that should be dispensed with, yet consider how feeble such Piles would stand in soft slutchey Ground, that the least Pressure from either Side, would give them all a lean to the opposite Side: Besides, these Piles must have several rows of Piles drove round them, which will leave very little Room for the Water, and that will increase its Strength, by which it will tear up the Bed of the River between the Piers, and require continual repair from the Day they conclude the Work finished, and so the Bridge would continue in a tottering Condition, and bring a constant Charge either on the Corporation of the City, or the Public, and probably would soon share the Fate of Sir *Humphrey Jervis's* Wooden-bridge before mentioned, and many others.

Now observe in said Plate XXVII, that a. is the Rock; b. Bottom of the thorough Foundation; c. Surface of the same; d. low Water mark; e. would probably be about the Surface of the Grating, whereon the Stone-work would begin, and so the Stone-work of this our thorough Foundation beginning at b. would be about 8 Feet below that of theirs, and all that soft Slutch would be thrown out, and a firm Stone-work put in the Place of it, which as I observed before, would wedge in and keep those Piles tight and firm together, and whence, your Overseers may be able to determine which of these Methods are most eligible.

It is not improbable, that the Persons who recommend this Method of building the Piers upon Piles, will offer this Argument to enforce it: That it will be a vast deal cheaper than the Method which I propose, and I admit, that for the present it may be so; but supposing it were possible to make it to stand any Time, it

would be infinitely more expensive toward the Conclusion, beside the danger of its falling immediately after the Centers are struck.

Mr. *Labely* has informed us Page 40, "that at *Moulins*, in *France*, they attempted to build a Stone-bridge upon Piles, driven about 15 Feet into the Bed of the River, the tops of which were strongly fastened together, and reached about five or six Feet above the Surface of the Bed of the River, but the Moment they attempted to ease the Centers on which they had turned the Arches, the whole fell into Ruin." Therefore, be advised and consider, that you have now before you effectual and proper Methods, by which you may easily accomplish this Work, all fully proved and ready to be put into Execution, with numerous Cautions dispersed throughout the whole, which you know was not the Case with me, who had every individual Thing to invent and to contrive, so as to answer these Purposes; never having either seen, heard, nor even read of any of them, saving only what I have already mentioned: And therefore, you will find, that you will have nothing to do but to follow these plain and easy Methods, all of which you are now made fully acquainted with.

END of PART the FIRST.

BUILDING in WATER.

PART II.

Concerning an Attempt to contrive and introduce quick and cheap Methods, for erecting substantial Stone-buildings and other Works, in fresh and salt Water, quaking Bogs or Morasses, for various Purposes; fully laid down and clearly demonstrated, by TWELVE PRACTICAL PROPOSITIONS; but not in any Case exceeding ten Fathom deep: Together, with a Plan for a spacious and a commodious Harbour for the *Downs in England*, projecting to 20 Feet deep at low Water.

CHAP. XIII.

Concerning some Methods made use of by the Antients, and on particular Qualities of Lime, Mortar and Grout.

MY Thoughts on this Subject, took their rise from an Observation I made on our taking up the Foundations of *Essex-bridge*, where we found that the Bed of sharp Gravel, on which the Piers had been built, was actually petrified seemingly into a close solid Stone, by the small Quantities of the petrifying Qualities of the Lime, that had sunk down into it, in about 70 Years, but principally since erecting the Effigy in 1722, which you have seen particularly noted in Chap. VI. Sect. 2. Together, with what I observed concerning the exceeding great Strength of the Mortar in the Foundation of the Pier, which I repaired in *Ormond-bridge*, and which is mentioned in my explanatory Notes on Plate XX. Letter A.

Having taken proper Notes and Observations thereon, and compared them with what *Palladio* has mentioned in his 1st Book, Ch. 9. Sect. 6. concerning some “ Walls called *Reimpiuta*, or *Coffer-work*, “ which were made by the Antients, by taking Planks laid Edge- “ ways, according to the Thickness of the Walls, filling the Void “ or Space between them, with Cement and all sorts of small Stones “ mingled together, and continued after this Manner from Course “ to Course: There are Walls now at *Sirmion*, upon the Lake *di* “ *Garda*, built after this Manner.” I say these principal Matters, and what I have learned from several other *Roman* Authors and antient Historians, have at length, produced what I am now about to lay before you, not in the least doubting, but you will take them into Contemplation, and improve the hints I shall give you, so far as you shall find them worthy your Notice; and likewise, to be productive of public or private Utility, those being my Motives for writing and publishing these Sheets, which I confess, has brought on me a very arduous Task, because I am conscious of my great Incapacity to perform such an undertaking; but yet, I presume, that if through the Course of my little Practice, any useful Occurrences have happened in my Way, it is better to leave them in the Possession of the Public, even irregularly cloathed in their poor homely spun Apparel, than to carry them with me to my Grave. And now as you know the Motives that have actuated my Endeavours, and the End I propose in this Part of my Work, and as I have such great Objects in View, I hope I shall be honoured with a serious and candid Perusal: That the Scope and Designs of this Work may be regarded, the real Importance of my Remarks and Contrivance considered, and not my Language or Expressions to be anatomised, as if those only were to employ the Attention of my Readers; for I study neither Stile nor Diction, any further than what I think necessary to communicate and render my Sentiments intelligible to my Readers, most zealously endeavouring to reduce all my adequate Ideas into the Forms and Figures exhibited on the ensuing Plates, which henceforward must principally govern and direct the Thread of my Subject.

S E C T. I.

Concerning Coffer or cased Walls or Foundations, abridged from
L. B. ALBERTI.

WHAT *Palladio* calls Coffers, the Translators of *Alberti* call Cafes, which in Fact are the same Things. In *Alberti's* 3d Book, Ch. 5. he recites various Methods made use of by the Antients, both in laying Foundations and in building Walls in Cafes, and among the rest, he expresses himself in these Words:

" I have observed, that in other Places the Antients, who were wonderfully expert in making of great Works, followed different Methods in filling up the Foundations. In the Sepulchre of the *Antonini*, they filled them up with little Pieces of very hard Stones, each not bigger than an Handful, and which they perfectly drowned in Mortar. In the *Forum Argentarium*, with Fragments of all sorts of broken Stones. In the *Comitia*, with Bits of the very worst sorts of soft Stones. --- I have known other Instances, where the Antients have much the same sorts of Foundations, and Structures too of coarse Gravel and common Stones, that they have picked by chance, and which have lasted many Ages.

" Upon pulling down a very high and strong Tower at *Bologna*, they discovered that the Foundations were filled with nothing but round Stones and Chalk, to the Height of nine Feet, the other Parts were built with Mortar; we find, therefore, that very different Methods have been used, and which to approve most, I confess myself at a loss, all of them having endured so long firm and sound; so that I think, we ought to choose that which is the least expensive, provided we do not throw in all Manner of old Rubbish, or any Thing apt to moulder." After his mentioning many other Things concerning Walls, he concludes this Chapter with these Words, " I therefore lay it down as an indispensable Rule, that all the first Course of Work from the level of the Foundation, should be composed of the hardest, soundest and
" largest

“ largest Stones;” but after that Course he treats largely of carrying up the out Sides, with cut Stones and filling (or stuffing as he calls it) the inside with small Stones, and Lime-liquid: And he concludes his 8th Chapter with this Observation, “ Lastly, we are taught, what I find constantly observed among the Antients, *never to admit any Stone among the stuffing that weighs above one Pound*; because, they supposed that small Stones united more easily, and knit better with the Cement than large ones.”

In his 10th Chap. are these Words, “ There are some, who observing here and there in the Works of the Antients, large Stones which where they join seem daubed over with red Earth, I imagine that the Antients used this instead of Mortar.” Chap. 11th, he says, “ but as we shall sometimes be obliged to make use of other sorts of Stones, whereof some are not cemented with Mortar,” or Grout I suppose, “ but only with Slime,” some tell us, “ that the Slime which is used for Cement, ought to be like Pitch, and that the best is that which being steeped in Water, is slowest in dissolving, and will not easily rub off. Others commend the sandy as best, because it is most tractable.---In antient Structures, we often meet with very strong Walls, made of nothing but Rubbish and broken Stuff, these are built like the Mud Walls in *Spain* and *Africa*, by fastening on each Sides Planks or Hurdles, to keep them together till they are dry and settled, but herein they differ, for some say, that the Antients filled up their Work with Mortar-liquid, and in a Manner floating.”

Numerous other Authors have transmitted these or the like Methods; but these are sufficient for our present Purpose, let us, therefore, in the next Place consider the Natures and peculiar Qualities of some of the Materials, which we are to make use of, for there are many Things necessary to be considered and strictly observed, before we enter into a full Discussion of our Subject.

S E C T. II.

Concerning Lime, Mortar and Grout.

I HAVE from my Childhood, been well acquainted with the Nature of Lime and Sand made in Mortar, of all sorts, that have been used in Buildings in these Countries, and tried numerous Experiments with them; on which, together with what I have observed and learned from old experienced Workmen, during the Course of upwards of sixty Years, I think, I can safely affirm, that good Mortar, that is, Mortar made of pure and well-burnt Limestone, and properly made up with sharp, clean Sand, free from any sort of Earth, Loam or Mud, will within some considerable Time actually petrify, and as it were, turn to the Consistence of a Stone. I remember I had one of my Remarks from an old *Scotch* Mason, which I shall give you in his own identical Words, that is,

When a hundred Years are past and gane,

Then gude Mortar is grown to a Stain; (or a Stone.)

My Father (who was a Workman about the Year 1675) often told me, and my own repeated Observations convince me, that the Methods Masons practised in former Times, in building Churches, Abbeys, Castles or other sumptuous Edifices in this Country, was to this effect. After they laid the out-side Courses with large Stones, laid on the flat in swimming Beds of Mortar, they hearted their Walls with their Spawls and smallest Stones, and as they laid them in, they poured in plenty of boiling Grout, or hot Lime-liquid among them, so as to incorporate them together, as if it were with melted Lead, whereby the heat of it exhausted the Moisture of the out-side Mortar, and united most firmly both it and the Stones, and filled every Pore (which as the Masons term it) set, that is, grew hard immediately, and this Method was taught to our antient Masons, by the *Romish Clergy* that came to plant *Christianity* in these Countries, and I affirm, that in many of such old Buildings, I have seen the Mortar, as it were, run together and harder to break than the Stones were.

But

But with respect to the Matter in hand, I admit that Mortar will not set or grow so soon hard in Water as upon Land; but I am fully convinced, that good Mortar will in reasonable Time grow as firm and as substantial in Water as upon dry Land; but not dwelling upon mere Reports, I shall come to Facts, and I do also affirm, that in pulling down *Essex-bridge*, and repairing *Ormond-bridge*, we found the Mortar of the lower Courses of the Piers better cemented to the Stones, than it was in the upper Works; for a wet Stone or a wet Brick imbibes the Mortar, and holds it faster than a dry Stone or Brick will do; the Dust and Dryness of either crusts the Mortar immediately, and the wet Stones or Bricks suck and unite with it, as for instance, take two Bricks equally well burned, wet one of them and lay it on a Bed of Mortar, and at some Distance from that lay on the other dry, let them lie so as long as you please, and then take them up, and you will find the wet Brick will bring up its Bed of Mortar with it, but the dry Brick will separate and leave its Bed of Mortar behind it.

There are several sorts of Lime-stone, some indeed, set much sooner and harder under Water than others, but any good Lime properly mixed, and tempered with sharp clean Sand, will bind and cement as effectually under Water as above it, as I hinted before.

What I mean by good Lime, is that which is made of clean, close-grained Lime-stone. All Marble is Lime-stone, but all Lime-stone is not Marble. All Marble will take a polish, but all Stones that will burn to Lime, will not take a polish. For instance, Chalk will make Lime, but it will neither polish nor make good Lime for any Purpose; therefore, I advise you to choose the closest grained, the hardest, and consequently the heaviest Lime-stone for any Work, but particularly for Water-works.

I need not explain what I mean by sharp, clean Sand, but I shall give this one Caution, that it is better to put too much Sand in your Mortar than too little. I know Workmen choose to have their Mortar rich, because it works the pleasanter, but rich Mortar will not stand the Weather so well, nor grow so hard as poor Mortar will do; if it was all Lime it would have no more Strength in Comparison, than Clay.

Now

Now let us suppose, that a Peck of Roach-lime was slacked into White-wash, and then mixed with two or three Barrels of sharp Sand, so that every individual Particle of Sand partook, and as it were, got a white Coat of this Liquid-lime, such Mortar, that would only appear to be mere Sand, supposing such could be wrought into Mortar, would sooner harden and petrify, either in or out of Water, than if there had been ten Times that Quantity of Lime made up with it; but nevertheless, observe, that I do not recommend that Proportion for Mortar, though it might answer for our present Purposes extremely well.

It is not within my Province to account for the petrifying Qualities of Lime-stone, Lime or Lime-water, though I have often heard, seen and read of several very remarkable Instances of each of them, but it is sufficient for my present Purpose, that they have these petrifying Qualities to great Degrees; but all sorts of Lime-stone have not this Quality in the same Proportion, yet I believe, no Lime-stone whatever can have more excellent Qualities than such as we have in, perhaps, every County in the Kingdom: And indeed, it has some useful Qualities not much known among the Generality of Workmen, as for instance, our Lime-stone will make exceeding good Tarras for Water-works, for which purpose you are to prepare it thus: Get your Roach-lime brought to you hot from the Kiln, and immediately pound or rather grind it with a Wooden-maul, on a smooth large Stone, on a dry boarded Floor, till you make it as fine as Flour, then without loss of Time, sift it through a coarse hair or wire Sieve, and to the Quantity of a Hod of your setting Mortar (which on this Account ought to be poorer than ordinary) put in two or three Shovels-full of this fine Flour of the Roach-lime, and let two Men for Expedition sake, beat them together with such Beaters as the Plaisterers make use of, and then use it immediately. This, I can assure you will not only stand as well, but is really preferable to any Tarras.

I will give you another Instance which will be hereafter found to come within our Subject, *i. e.* the making Cisterns in which Tarras is generally used in ordinary Work, build all your outside and inside Rows or Courses with wet Bricks, and with Tarras-mortar made as above directed; observing, that your Mortar is to

be a little too soft for Work, and then the heat of the Lime-flour will bring it to a proper Consistence immediately; but never throw Water upon it when you are beating it, for that will chill and slack your Lime-flour, which you ought most carefully to avoid, but make the Men temper it with the utmost Expedition, and what you want in Water to make it fit for your Work, give it in Elbow-grease; and this Rule ought to be observed in making all sorts of Mortar.

The Grout which you lay your middle Row with, must be thus made (in a Tub or Bucket) pour your Water on the Roach-lime, which must be pure and well burned, very leisurely; and when it is boiling, you may strain it through either a wire or hair Sieve, so as it may be tolerably free from Stones, and then let it be used directly, and be sure your Sand is sharp and clean, and when you are using it, do not take the thin that is uppermost, but stir it up and take plenty of the Sand with it; but in Masons Work, when the outside and inside Courses of cut Stone are set, pour in this boiling hot Grout, and instantly lay down your middle Course of wet Bricks between them, in double or single Rows of Stretchers, braking Joints as usual, according as the Largeness or Smallness of the Work may require, and that will press and squeeze the Grout into all the inside Pores that are next to it, and so they will all unite, and by the heat of the Grout and Dryness of the Bricks, they will all set together immediately, and become staunch and solid; but if you were making a Cistern of rough Stone, mix one fourth of the Powder of Tiles, or well-burned Bricks with your Mortar.

C H A P. XIV.

Coffer-work applicable to various domestic Purposes, as introductory to building in deep Water.

I HAVE already observed, that the Word which the Translators of *L. B. Alberti* have rendered *Cases*, the Translators of *Palladio* have rendered *Coffers*; and that it is evident, those two Words convey to us the same Thing in Fact; but in what I am
now

now about to lay before you, I have confined myself to the Word translated into *English* from *Palladio*, that is, *Coffer-work*, as I apprehend for several Reasons, it is most proper for our Purpose; and as we have now fixed on a technical Term for this Method of working, let us in the next Place, endeavour to apply and extend that Method to building in Water, wherein we shall have great Occasion for Timber.

S E C T. I.

Concerning Oak and Fir Timber.

WE have very little Timber now of the Produce of this Kingdom of any kind, but large Quantities of both Oak and Fir imported; on which two sorts, I shall make a few Remarks.

Oak, is generally allowed to endure all Seasons and Weathers, better than any other sort of Timber, and some People are of Opinion, that it is the best of all others in Water. I know the Pier or Piles, which we began to run out in this Harbour about the Year 1728, have long since sufficiently proved, that it was not by any Means adequate to that Purpose, tho' I do believe, that there is not any Country that produces better Oak Timber than ours, notwithstanding, those Piles rotted and decayed in a very short Time; but whether that was owing to the Nature of that particular Timber, or to any Thing peculiar to our Harbour, I know not, but it reported there is a sort of Worms that either breed in or are nourished in those Piles, that totally destroy them.

There are, indeed, several Methods that have been made use of to preserve Timber. Sir *Hugh Platt*, informs us, that the *Venetians* make use of one, which seems very rational, *viz.* to burn and scorch their Timber in a flaming Fire, continually turning it round with an Engine, till it has got a hard black crusty Coal upon it. --- Others inform us, that the *Dutch* preserve their Gates, Portcullis's, Draw-bridges, Sluices, &c. by coating them over with a Mixture of Pitch and Tar, whereon they strew small Pieces of Cockle and

other Shells, beaten almost to Powder and mixed with Sea-sand, which incrusts and arms it wonderfully against all assaults of Wind or Weather; but for my own Part, I conclude, that the *Venetian* Method is preferable, because I believe, it is the Sap that is either in Oak or Fir, that is the principal Cause of their decaying so soon. Besides, that Sap probably breeds and nourishes the Worms that are natural to it, but there are not any Worms peculiar to the Water that I have ever heard of.

Worms generally breed in the Sap of all kinds of building Timbers, and have a powerful Effect on them, either without or within Doors; and all old and dry soft Woods breed them in great Abundance, just as Mites are bred in Cheese; and some of these Worms are a quarter of an Inch in Length, and near a tenth of an Inch in Thickness; and in very footy old Cabbins where soft Woods are generally made use of, they are to be found in great Abundance. For these Reasons, you ought to be exceeding careful how you make use of any sort of sappy Timber, but particularly in all Works that stand the Weather, for the Sap is of a corrosive Nature, and for that Reason ought not to be made use of, especially before it is a little seasoned in any Work that requires to be durable.

I know there are Carpenters who pretend it is necessary to paint their Work directly, and I admit that in some Cases it may; but it ought to be done with Judgment, and not merely to varnish over and hide the Imperfections of their Work. As the Preservation of Timber is a Subject suitable to our present Purpose, I advise you never to paint either green or sappy Timber of any Kind.

When I was building the Mansion-house of *Ramsfort*, one Day after Dinner, Mr. *Ram* observed to his Company, that he had some Time ago, cut up some of his own Fir Timber into Scantling, out of which he had a great Number of Field-gates made, and that several of them that had been hung up near his House, he had had painted immediately, but those that were at a Distance through several Parts of his extensive Demesne, were not painted; that those which were painted were all quite rotten, but those that were not painted continued firm. The Company seemed surprized at this Information, and Mr. *Ram* enquiring of me the Cause of this apparent

rent Phænomenon, I readily answered, that the painting of the sappy Wood, encrusted and confined the Sap, and prevented its being exhausted by the Sun and Weather, and being continued within it, preyed upon, putrified and destroyed the hearty sound Wood. As to the Wood that had not been painted, the Sun and Weather consumed and exhausted its Sap, and thereby rendered it of a proper Consistence, and made it well seasoned. It is for this Reason I advise against painting, or otherwise encrusting sappy green Wood, unless you have some very powerful Reasons for it.

I once happened in Company with a very ingenious Gentleman, one Mr. *Smith*, who was so kind as to communicate a Secret to me, which struck me greatly, and I instantly put it in Practice, and am now convinced it is an excellent Method to make red Fir Timber near as durable as Oak, *i. e.* After your Work is tried up or even put together, lay it on the Ground with Stones or Bricks under it to about a Foot high, and burn Wood (which is the best firing for that Purpose) under it, till you thoroughly heat and even scorch it all over, then, whilst the Wood is hot, rub it over plentifully with Linseed-oil and Tar in equal Parts, and well boiled together, and let it be kept boiling whilst you are using it; and this will immediately strike and sink (if the Wood be tolerably seasoned) one Inch or more into the Wood, close all the Pores, and make it become exceeding hard and durable, either under or over Water; and if there should be any sappy Parts in it, they will receive such benefit by the Fire and Heat of this natural and penetrating Liquid, that they will also thereby become exceeding durable. Good red Fir prepared after this Manner, will for many Uses last as long, if not longer even than Oak Timber, especially in Water; and if good Fir Timber is constantly kept in Water, it will keep fresh and sound much longer than Oak.

I have often seen slating and plaistering Laths, clove out of Bog Oak and Bog Fir; in cleaving the Fir Laths, I frequently observed the Turpentine as fresh and firm in it as if it were perfect Rosin; and I have heard of the Splinters of this Wood being used not only for Torches, but by poor People sometimes as Candles. In the Butt of a clean Trunk of a Bog Fir-tree, it will split thin and tough
like

like Whale-bone. It is a generally-received Notion that the Timber Trees which are found in such Abundance in some of our Bogs, have lain there ever since the great Deluge, but be that as it may, the Bog Oak Timber is always found to be frushey, dozed and short grained, and not near so sound as the Fir Timber, tho' both taken up at the same Time out of the same Bog. Hence I think we may safely conclude, that red Fir Timber is exceeding durable, and consequently unexceptionable as to our present Purpose, provided it be kept entirely under Water; therefore, let us determine to make our Coffers of good sound red Fir Timber, and keep them under Water as much as we conveniently can.

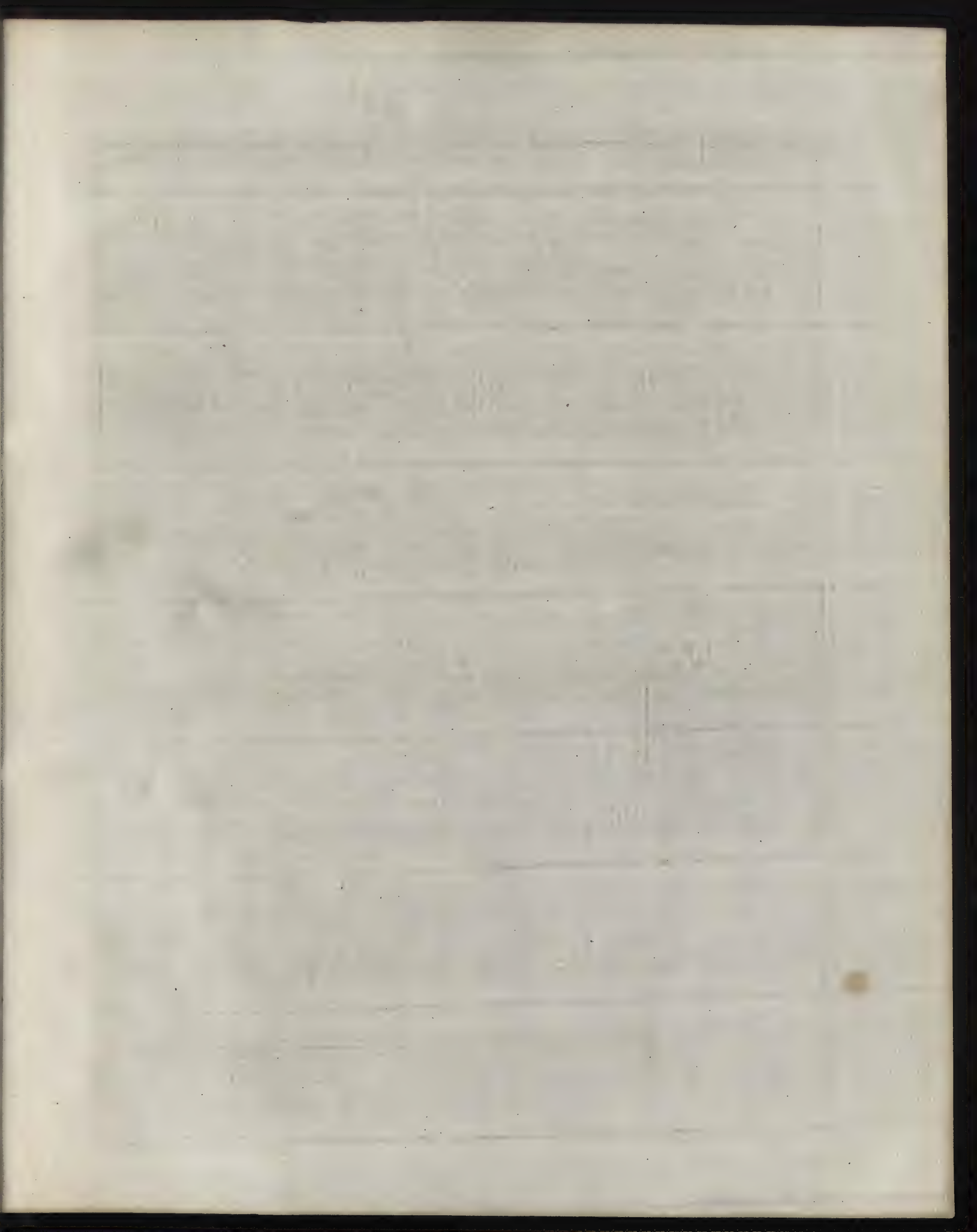
S E C T. II.

Of the Construction of Coffers, and the Uses to which they may be properly applied, for building in Water.

BEFORE we can fix upon the Constructions of the Coffers, we must have some Particulars proposed, because that which might answer for one Purpose, might not answer for another: I intend, therefore, as briefly as possible to shew some of the Uses to which they may be applied. And you may be assured, I shall leave you Room enough to exert your own Genius, by adopting them to other Purposes.

I am sensible that at the first Appearance of any new Project, some may be vehemently for, and others against it; but I hope you will not suffer yourself to be prejudiced on either Side, but deliberately examine the whole of what I propose. And I shall begin with such a plain and easy Proposition, as will come within even the Capacity of any sensible Journeyman to form a Judgment upon, and thereby lead you gradually into the practical Part at a mere trifling Expence.

P R O P.



Pl. 28.

F. 2

d

a

c

b

b

a

B

A

F. 1

b

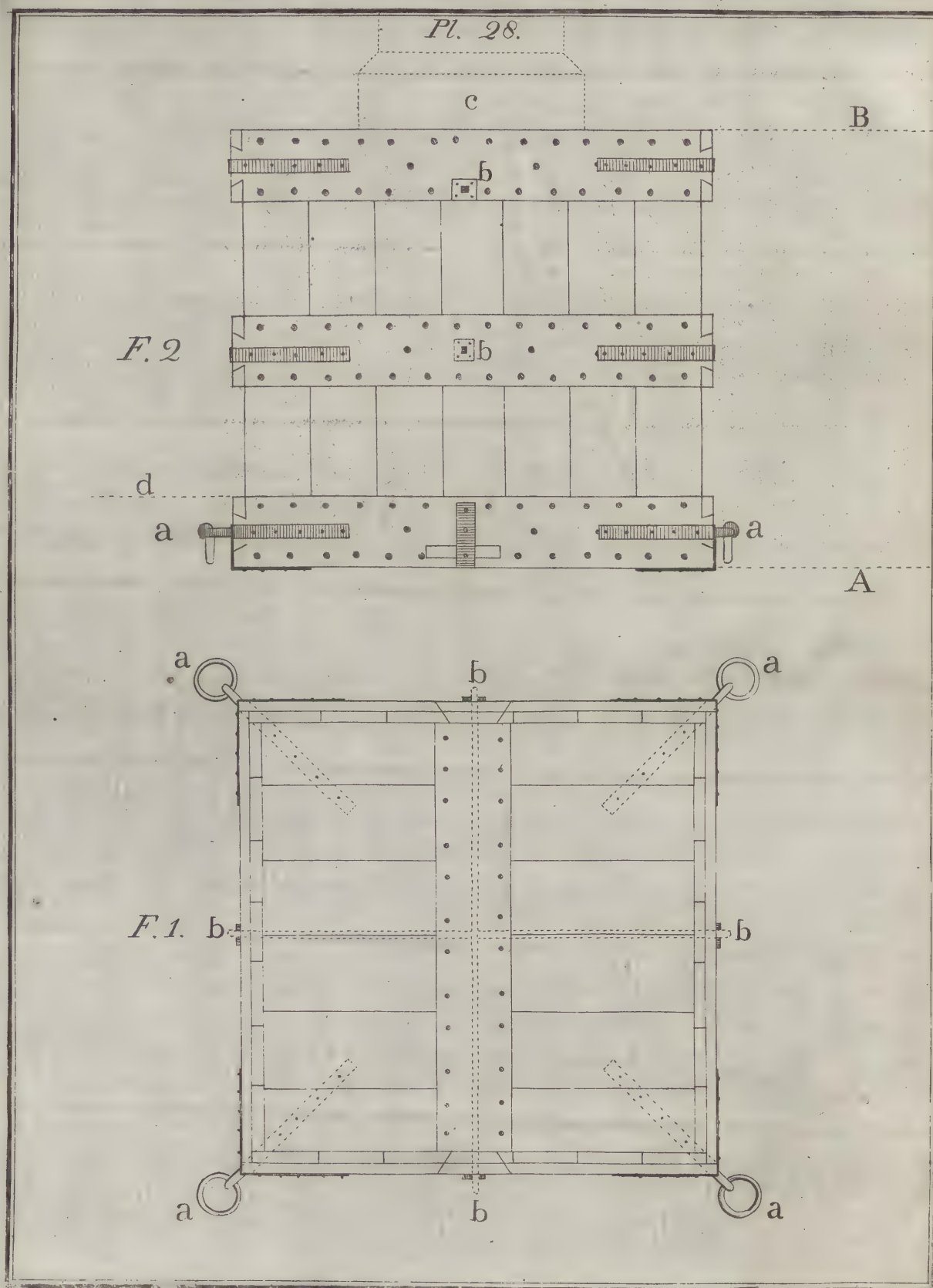
b

b

a

b

a



PROP. I. *A Gentleman has a Bason of Water in his Garden, he requires a sure, quick and cheap Foundation to be laid therein, sufficient to sustain a Statue of Lead, on a Stone Pedestal, the Plinth of which is three Feet square, the Water six Feet deep.*

METHOD laid down in PLATE XXVIII. Scale 2 Feet 1 Inch.

Fig. 1. Represents the Plan or Bottom of the Coffin, which is to be made of only Inch and half Plank, which you see will require six Planks of about six and a half Feet long each, and in the Middle across them, there is to be a Ledge nailed on with Dog-nails, and dovetailed at each End into the opposite Sides, and all the Bottom and upright Planks are to be dovetailed together also.

Fig. 2. Shews you the Elevation or out-side thereof, in which you see there are seven Planks placed erect, with three Belts surrounding the whole, and they also are to be dovetailed at the Angles, and strapped with Iron: Each of the four lower Straps, a. are to have a third Plate turning down, and nailed in a diagonal Manner on the Bottom, which you see dotted out, and each of the four Squares are to have a strong projecting Neck, through the Ends of which there are to be either Rings or Holes, to run Ropes through them, each of which Ropes is to be at least three Times the Depth of the Water, that you may the easier manage it in the launching and fixing it in its Birth: Each of these Ropes is to be doubled together, and fixed to a Wooden-block to buoy them up, which you may throw into the Coffin till you want them. In this Fig. 2. A. is the Bottom of the Water. B. Is the Surface. b. Brace Bars, and c. the Plinth of the Pedestal, which will seem to stand on the Surface of the Water; for you may remember that we resolved to keep all our Wood within the Water. d. Bank or filling to preserve the Lime-water.---Having thus fully considered the Construction of the Coffin, let us consider the Nature of the Foundation that is to be laid in it, *i. e.* the Stuffing, which is to make it a solid and a substantial Foundation for the Pedestal.

SECT.

S E C T. III.

Of stuffing the Coffers and Petrifications, laid down and to be considered as general Conclusions.

THE Word *Coffer* is borrowed from *Palladio*, we shall borrow the Word *stuffing* from *Alberti*, who has treated largely upon it; and strictly observe, that before the Coffer is launched, you are to be provided with sufficient Quantities of very small Stones, clean and sharp sandy Gravel, and Roach-lime ready at the Kiln whenever it is called for; and with these Materials you are to fill or stuff the Coffer, so that the whole may be justly proportioned and stuffed as solid and as compact as possible.

In order to learn the true Proportions and Quantities of the stuffing, I made the following Experiment. I had a Box made of one exact cubical Foot, which held 200 Stones fit for the Purpose, each Stone on an Average, weighing about seven or eight Ounces, the whole consequently weighed 90lb. nearly. The same Box held about 80lb. of tolerably dry, sharp and rather fine sandy Gravel, without any sort of Stones, except those small ones which are usually among Sand. Part of those Stones I put again into the Box in thin Layers, filling all the Interstices or Vacancies with the Sand, and after that Manner it contained 80lb. of the Stones, and 40lb. of the Sand, and I know it would also have held the proportionable Complement of Roach-lime, that is 10lb. made liquid as before treated of, which together gives the just Quantities and Proportions of 10, 40 and 80, or 1, 4 and 8, which will be much easier remembered, and must be strictly observed; and to this Purpose, you must depend on some careful and faithful Rough-mason or Bricklayer. And also, please hence to observe, that one cubical Foot of this stuffing will weigh 130lb. which is nearly the same Weight of one solid Foot of *Portland Stone*.

There are three different Methods for making use of the Lime in such Work as this; one is, to mix the Roach-lime made liquid, with its Proportion of Sand and small Stones in such Manner, as
may

may cloath every Stone and Particle of Sand with it. The second, to slack and turn them all up together like Mortar. The third, to lay each of the three, as it were, in very thin Layers, still observing the same Proportion, take which of these Methods you please, provided the Roach-lime be, however, carefully and judiciously mixed with the Stones and Sand, for if these Materials are not equally mixed, how can you expect them to petrify and unite into one solid Mass? But if they are properly mixed together, the whole stuffing of this Coffin, will actually petrify, and become one solid and compact Substance, as hard and as closely united together as if the same was in one Block or Rock, and it will be many hundreds of Years before the Coffin (being in Water) will be in the least decayed.

I have some other Cautions to give you concerning the small Stones you are to make use of. Let none of them exceed an Handful, or one Pound Weight, as before mentioned; and if you can conveniently, let them all be Lime-stone, broke into Stones of about that size, carefully preserving the very dust and least Scrap of them for Use.

I before declined touching on Petrifications, and I now suppose that you do admit that there is a petrifying Quality both in Lime and in Lime-water, and there are incontestible Proofs of this petrifying Quality being in Lime-stone, even without Calcination. As for Instance, Doctor *Thomas Molyneux* says in his *Natural History of Ireland*, Page 184. --- " There was one Urn found in " a little sandy Hill, near *Cooks-town*, on the Road to *Liffon*, in " the County of *Tyrone*, it was covered with a great rude Lime- " stone, which being removed in order to make Lime, the Urn " was discovered in a Hole encompassed with six Stones of equal " Bigness, which made a Hexagon, in which the Urn stood. The " Water that had fallen on the Urn from the Lime-stone, or the " Air condensing, had petrified and made a Stone-crust on the " outside thereof." And further observe, that if the poor scanty Pittance of that petrifying Quality, that soaked from the Lime of the Piers of *Essex-Bridge* into the Bed of Gravel, that was on all Sides open and exposed to the Rapidity of the Water, had so

N^o 1. powerful

powerful an Effect as before-mentioned; we may certainly conclude, that pure Lime-water will petrify sharp Sand, but cannot make it cement. And the stuffing of these Coffers, will actually petrify also, (particularly if they are done in the Manner above-mentioned) and that in a much shorter Term than may, perhaps, be expected. If you search among the *Roman* or antient Historians, you may find numerous Accounts confirming the petrifying Qualities of these three Materials, when they are mixed together: And besides those I have already furnished you with, consult *Chambers's* Dictionary, under the Article ROAD, and read *F. Menestrier's* Observation, which I shall give you in its proper Place.

As I have desired you to preserve and use even the Powder, or smallest Fragments of the Lime-stone, I shall here assign my Reason for it, which is, that the Powder of fresh quarried Lime-stone, (which you will find to have a sulphureous smell, partaking greatly of the smell of Gunpowder) has this petrifying Quality to a very high Degree, and that Calcination heightens that Quality, is universally agreed to; but yet it does not operate in that Manner, used alone. For instance, if Lime be left to lie by itself, either on Land or in Water for thousands of Years, it would neither petrify nor come to any Degree of Hardness, nor would Sand alone petrify; but when these two unite, they begin to operate powerfully upon one another.

In order to come at a thorough Knowledge of this petrifying Quality, I would recommend the following Experiment: Take ten Pounds of Lime-stone fresh quarried, pound it into very fine Powder, and take the like Quantity of sharp, clean and fine Sand; get thoroughly burnt Roach-lime hot from the Kiln, the like Quantity; put it in a Vessel and pour Water upon it leisurely, and stir it gently till you find it is all dissolved, and as it were melted into a hot Liquid; rub and thoroughly mix the Flour of Lime-stone with the Sand, and without letting that Lime-liquid have Time either to cool or evaporate, stir in and most effectually mix and work them all together very stiff, and beat them thoroughly on a clean boarded Floor, and then make this Mortar into Blocks, about the Size of a Brick; bury one of these Blocks in very damp or wet
Ground,

Ground, put another entirely in Water, and keep a third in some dry Place: Now I am confident, that each of these Blocks will in a reasonable Time actually petrify into Stone, and become as much so as if they had been cut or wrought out of a Rock, and that they will endure Calcination, and become good Lime afterwards, but not so rich as that was from whence they derived: And with respect to Time, that which is deposited in the Bowels of its own natural Mother, will grow the first into Stone; that laid in the Water, will be the second, and that which is kept in the dry Place, will be the last and of a short brittle Nature: But the first, if in a large Block, will not only become hard, but stout and stubborn, and would stand and give great Resistance to a Hammer or Punch: The second, would be more free: And the third, fly off short. I apprehend that this little Experiment is worthy of Attention, because, by ascertaining the Time of these Deposits, and trying the Blocks from Time to Time afterward with a Tool or the Point of a Penknife, some useful Knowledge might be obtained; but be that as it may, these are some of my Reasons for recommending Lime-stone. However, where that cannot be conveniently got, you must make use of such hard Stones as you can get, but be sure you have them broke to the Sizes above-mentioned, for such will most assuredly cement and unite together with the Lime and Gravel, and each of the Stones will contribute to sustain the Confidence reposed in them; whereas, if one large Stone was put in among them, it would not unite but stand up stiff, and thereby be a great Means of shifting the Weight from itself, and throwing it on the small Stones that surround it, and consequently would overturn instead of supporting the Weight which it was destined to bear. For these, therefore, and many other Reasons, I most earnestly recommend it to your Practice, to use no other but small Stones in your stuffing.

You are also to take particular Care, that your sandy Gravel is sharp and clean, and of that Degree of Fineness as may contribute proportionably to the Solidity of the whole, and not to throw your Stones in one Place, and your Lime and Sand in another, but let them be all equally mixed throughout the Work, and all this can

be easily done; for let the Water be of what Depth it will, or your hurry ever so great, this you may do, and you are not to neglect it. And observe also, that this sort of Work can be much more effectually done in Water, than upon dry Land, even admitting that it was to be done with wet Grout, because these three Materials being thrown in proportionably together, each Stone and every Particle of the Gravel and Sand, will take Possession of a Place suitable to it; but the Sand in particular, will continue in quick Motion till it finds out a place of rest proportionable to its Size, and instantly fill up the most minute Vacancy, (provided that you observe these Directions properly) and immediately become as compact and as solid as a Bank of a Gravel-pit that has been formed by Nature.

But after all I have said, you may, perhaps, imagine that this stuffing, even so managed, will not be sufficient for our present Purpose, without giving it a long Time to settle and cement; and I grant it would not be amiss to allow it some short Time, to give the finer Parts of the stuffing Time to subside, supplying it with these finer Parts, till it will receive no more; and if these hard and substantial Materials are made solid and compact, and closely confined together, how can they settle or prove insufficient even before they are cemented? Now I ask you, do you believe, or did you ever hear any experienced Man say, that close gravelly Ground was not a substantial Foundation? And is not this in all Respects, at least equal to it? Because, it is actually Stone resting upon Stone, of different Sizes down to the minutest Particle of Sand all compacted together into one solid Mass. *Palladio* has furnished you with his Opinion in the tenth Page, and says, "You should choose a Place where the Bed or Bottom is even and uniform, and is either of Stone or of Gravel, because Stone or Gravel are excellent Foundations in Water." And herein lies the grand Advantage that will attend all these Projects, *i. e.* they are to be executed in Water, and if we supply the Water with due Proportions of this stuffing judiciously, it will take great Part of the trouble from us, and will, as it were, dispose of every Particle of the finest Sand, and with incredible Expedition convey it into such Interstices and
small

small Pores, as it will find fit to receive it, and if it does not fit or get room in one Place, it will instantly conduct it downwards by its own Gravity, till it gets it properly settled, which I presume, no human Art could so effectually accomplish; and I think it also advisable to propose the following Experiment.

When this little slight Coffin is made and stuffed with wet Grout, to within five or six Inches of the Top, level it so that every Stone on the Surface, may come to a proper and equal bearing, and cover it all over with a Coat of Grout; expose it then to the View of judicious Persons, and get their Opinion of it, and then Floor it all over with cut Stone, after a Workman-like Manner: It will then effectually sustain the Weight of the Statue, which in this Case is the Thing required; but in order to sum up and finally determine the Utility of these Speculations, which are in a large Degree the Base and Foundations of the following Propositions; let us particularly recollect, examine and consider well, what *Alberti* has transmitted down to us; that is, “ Upon pulling
“ down a very high and strong Tower at *Bologna*, they discovered
“ that the Foundations were filled with nothing but round Stones
“ and Chalk to the Height of nine Feet.”

Let me, therefore, recommend it to you, to get a square Pit dug, suppose of 9 Feet deep and as many broad, the Length at Discretion, and let that be done near a Pump, or convenient to some Water, and when it is filling with these Stones and sandy Gravel, supply it most plentifully with Water, to convey the Sand into all the Vacancies, but put neither Lime nor Lime-water in it, and when it is filled level to the Surface, throw more Sand and plenty of Water over it, and let the Men (with the back of their Shovel) beat down all irregular Stones, and make an even Surface as before mentioned, but do not then Floor it with cut Stone, but get some Gentlemen or other skilful Persons to view, to prove and examine whether or no that is a substantial Foundation, whereon to erect the most weighty Building immediately. And if it be given in the Affirmative, as most certainly it will, then consider also, that if the Lime or Lime-water was properly compounded with those materials, then would the whole be endued with this great and remarkable
 Advan-

Advantage, *viz.* The longer it will stand, the harder and more durable it will grow; and if the Pit was a Mile Cube and stuffed in like Manner, it would be all the same in effect.

S E C T. IV.

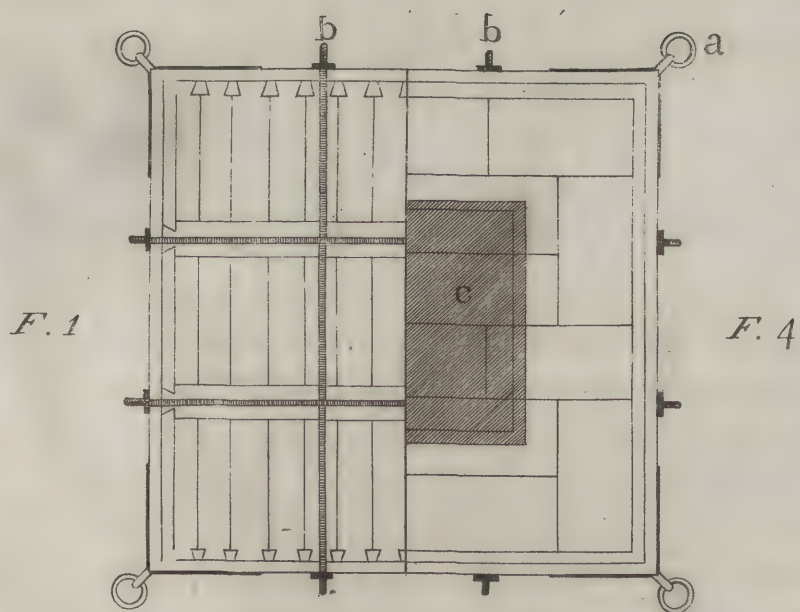
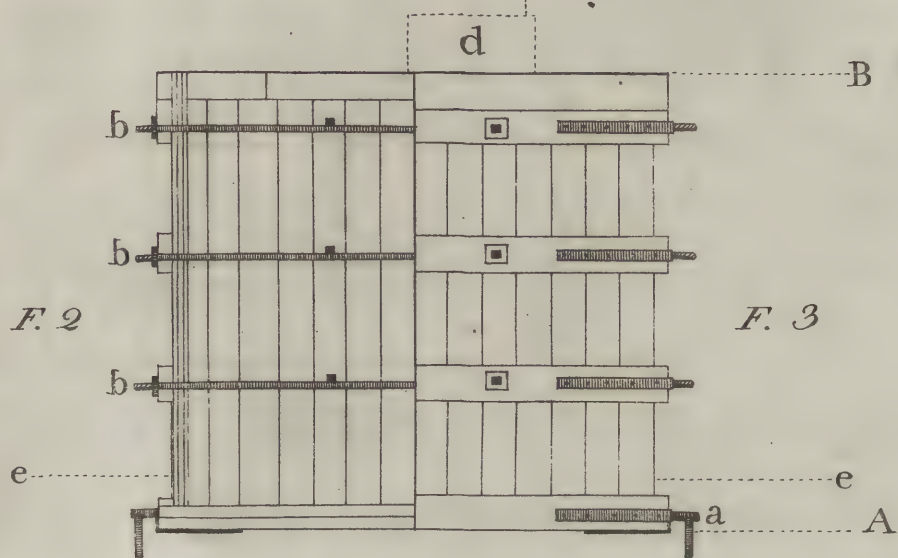
Concerning two other more weighty Purposes to which these Methods may be applied in still Water.

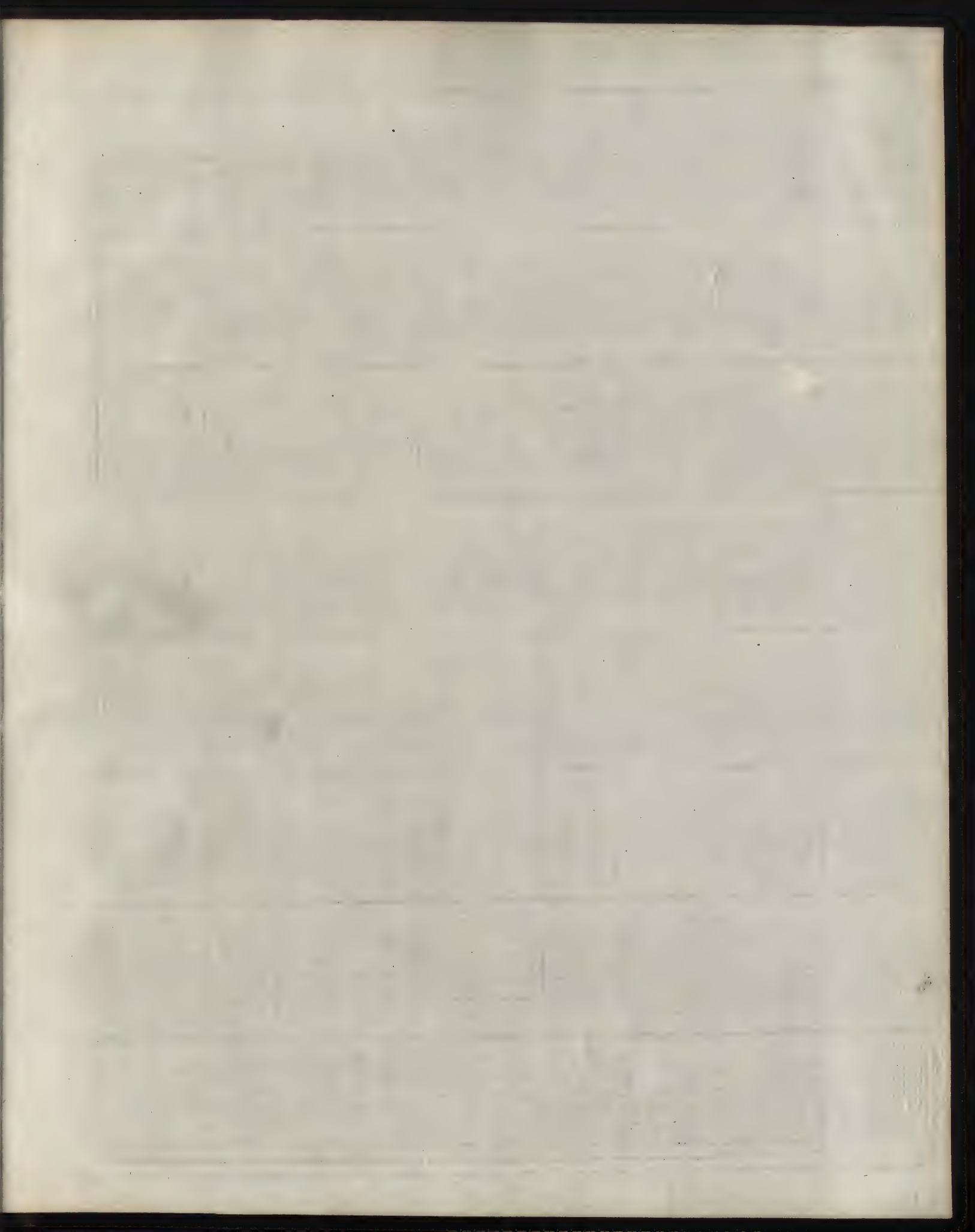
PROP. II. **L**ET us suppose that a Gentleman has an elegant Visto, terminated by a spacious Canal, the Water in which is twelve Feet deep, and he requires a Foundation to be laid in it, whereon he intends to erect an Obelisk of 36 Feet high.

METHOD laid down in PLATE XXIX. Scale 5 Feet 1 Inch.

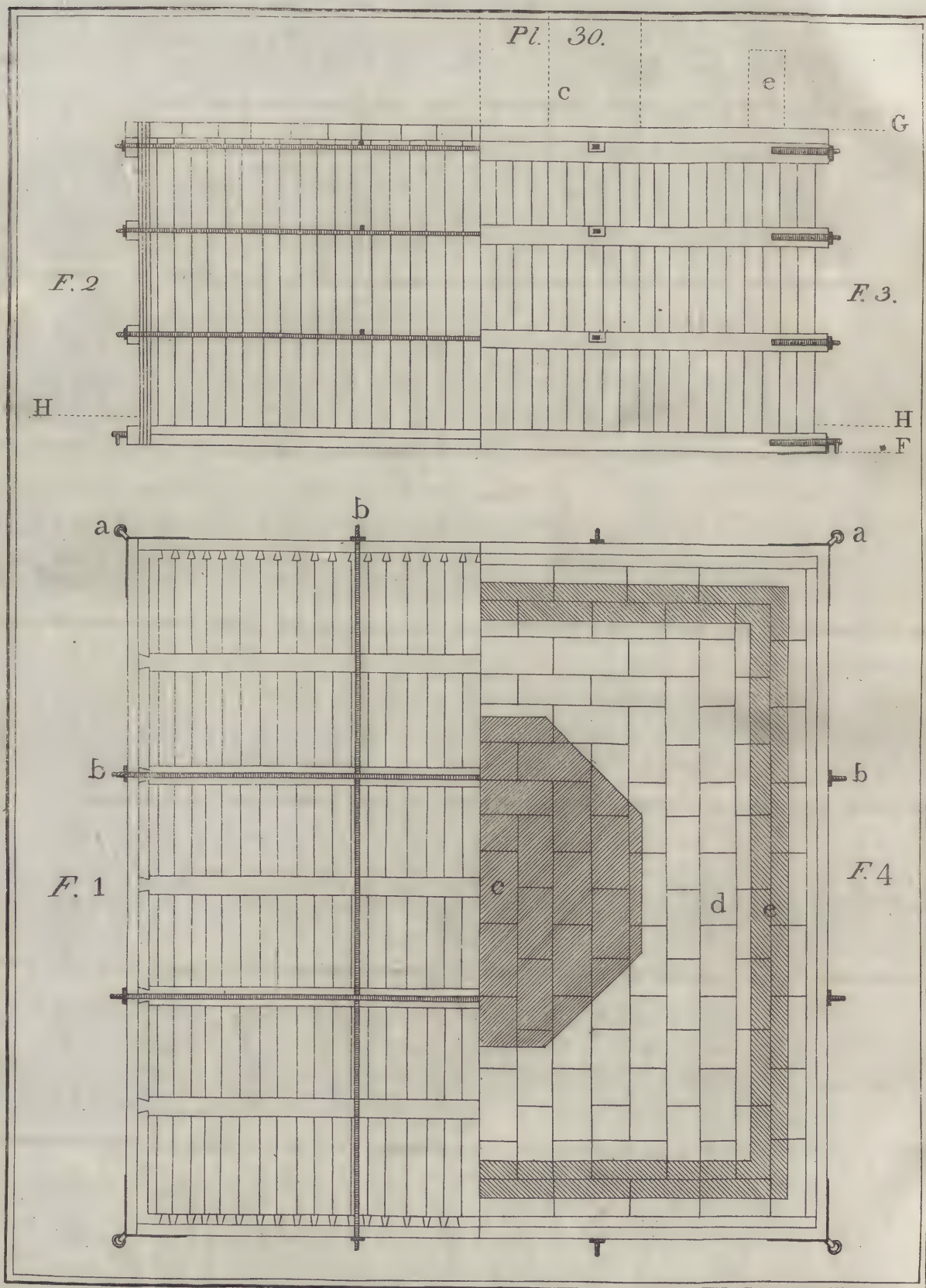
Wherein note, Fig. 1. Half of the Plan or Bottom of the Coffin, which is to be made of four or five Inch Plank. Fig. 2. Half of the Section. Fig. 3. Half of the outside erect, dovetailed and surrounded with 5 Belts, and Fig. 4. Half of the Platform which is floored with cut Stones of 4 by 2 Feet, and a Foot thick. a. The Rings for Hauling and fixing the Coffin. b. Brace Bars, Chains or Beams as most convenient. c. Site of the Obelisk. d. Plinth of the Pedestal. e. Bank to confine the Lime-water.

Let us also suppose, that a Nobleman hath a large Piece of Water adjoining his Pleasure-garden, from a particular Place in which, he and his Company have frequently been highly delighted with beholding several beautiful Prospects, from his Pleasure-boat; and he has a very public Spirit, and is desirous to enlarge the general Beauty of that highly improved Country, the better to enjoy the Benefit of the wholesome Air, he is determined to have an elegant octagonal Pavilion or Pleasure-house of 18 Feet Diameter, built in that particular Place; that the respective Windows may take in the Views of the natural Landscapes: And he also apprehends, that when the Windows are fully illuminated, a Band of
 Martial





Pl. 30.



Martial Music, &c. on rejoicing Nights, will contribute greatly toward the Amusement of the Nobility, and the adjacent Neighbourhood. Therefore,

PROP. III. *You are required to build a Pavilion of cut Stone, in a Lake of fresh Water eighteen Feet deep; the Platform to be enclosed with a Parapet of the same, extending 34 Feet square.*

METHOD laid down in PLATE XXX. Scale 8 Feet 1 Inch.

Fig. 1. Is the Plan or Bottom of one half of the Coffer. Fig. 2. Section or inside of the same as if it were floored with cut Stones. Fig. 3. Elevation thereof. F. Bottom of the Water. G. Surface of the same. H. The Bank, and Fig. 4. The Platform floored with cut Stone of one Foot thick. Wherein note, a. Launching and hauling Rings. b. Represents the Situation of the Brace-bars, which in this Work ought to be much rather small Boom-chains, and Brace-beams alternately. c. Scite of half of the Pavilion. d. Walk, round the same. e. Parapet-wall.

This Coffer is to be furrounded with a double Belt above, and three single Belts below them, as in the last Proportion; and they are to be dovetailed and plaited with half flat Bar-iron. All these Belts are to be both bolted or spiked to the Hull or upright Piles, and also pinned with Oak Trundles of about $\frac{3}{4}$ Inch Diameter, which are to be driven in the outside, and wedged within-side. Both the upright Piles of the Hull, and all the Belts, you may see by the Scale, are to be six Inches thick. The stuffing the same as before directed, and to prevent Repetition, I shall omit several other Matters, which you shall be made fully acquainted with, through the Progress of the following explanatory Notes, which you are to apply according to your own Judgment. Let us now endeavour to point out another Method of working in Water, for instance, in fresh Water Rivers.

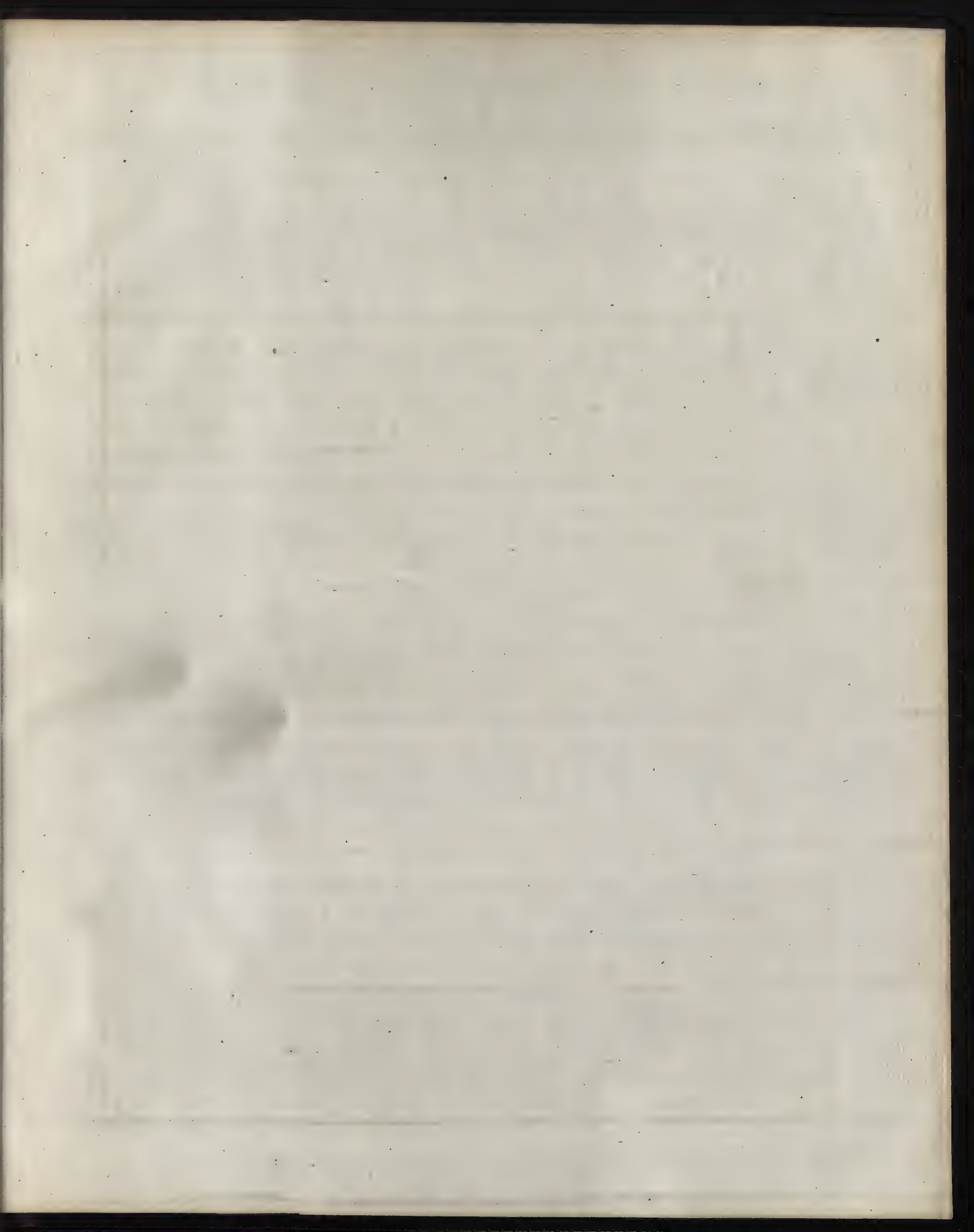
C H A P. XV.

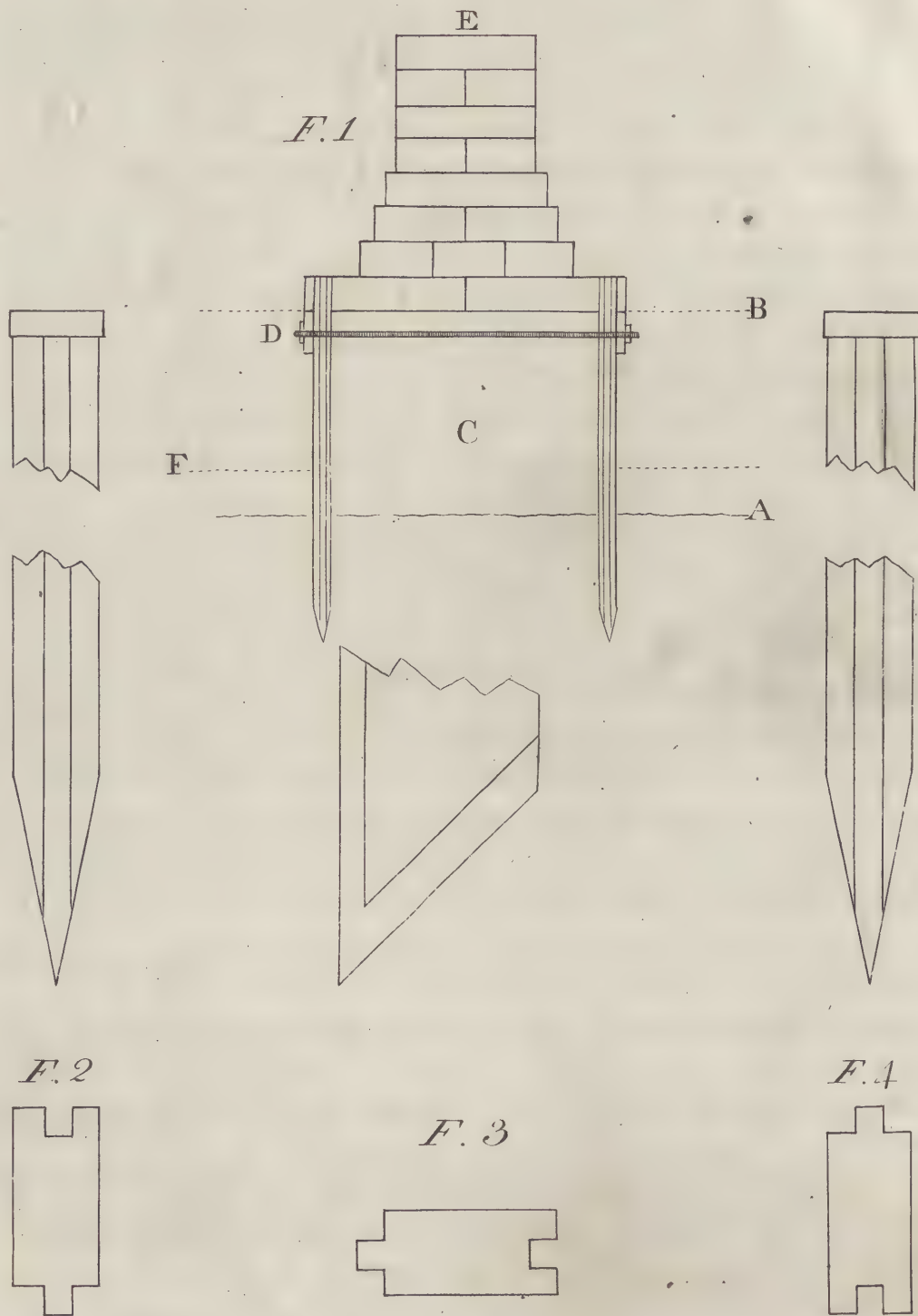
Concerning another Method for laying of the Foundations for the Piers of Stone Bridges, in large and deep Rivers.

THERE have been various Methods practised in laying the Foundations for the Piers of Bridges, in large and deep Rivers; but they have generally proved so extravagantly tedious and expensive, that the Public have been quite disheartened and deterred from even attempting such a Work, notwithstanding they labour under great Inconveniencies for want of them, especially in large Towns and Cities, and in all populous Countries, through which such large and deep Rivers run.

Now I hope by this Time my Readers have been able to form some kind of Idea, concerning what I mean by Coffers; and if so, let us apply our utmost Endeavours to remedy the great Disadvantages which the Public are labouring under, by contriving some other sure, quick and cheap Methods for that Purpose; in order to which, I recommend it to you in the first Place, to make yourself thoroughly acquainted with the Bed of the River on which you intend to work: Some, you must be sensible are hard, some soft, some partly consisting of both, some are very smooth and even, and others may have large Rocks or tumbling Stones, &c. You must, therefore, make a firm Resolution, never to sit down to design the Bridge, nor to consider the Construction of your Coffers, till you have most carefully tried, and searched diligently into the Bed of the River, which you may easily do by the Methods formerly directed, let the Depth of the Water be what it will in Moderation: And when you have collected and figured down your Soundings and Borings, you may proceed, and consider the gross Dimensions of the Bridge, and the Constructions of your Coffers.

But I presume, we may venture to establish one general Rule, concerning Bridges in particular: *i. e.* To proportion the Bridge to the Depth of the Water; as for instance, if the Water be three Fathom deep, your Coffer must be 19 Feet high, and at least 18
Feet





Feet broad in the clear, and it will stand as firm as a Cube. And you must adhere closely to *Palladio's* Rule, which is, "that the Foundation must be as thick again, as the Wall intended to be raised upon it;" but you must by no Means follow his next Direction, *i. e.* "to make the Foundation wider in soft loose Ground," for that would make the Bridge quite preposterous; but you must strengthen the soft Ground with Piles to such a Degree, as may bring it to an Equality with the rest of it, (as I did at the two northerly Piers of *Essex-bridge*, see Plate XIV.) I say, if the Water is 18 Feet deep, your Coffer must be at least 18 Feet broad, and consequently the Pier 9 Feet thick; which (if executed as represented in Plate XV. Fig. 1, 2 and 3,) will admit of an Arch of 54 Feet Span; and it is my Opinion (with Submission to some eminent Gentlemen) that the Breadth of a Bridge should be determined by its Height alone, or that the whole Bridge taken together, must bear some Analogy to the Depth of the River; for the higher the Superstructure, the greater extent the Foundation requires; but as there are numerous Books extant on this Subject, you may consult them, and let us keep to our Text with respect to the Foundations of Piers, and on this Subject as before, we shall begin in shallow Water.

S E C T. I.

PROP. IV. **I***T is required to build the Piers of a Stone Bridge, in a fresh Water River of one Fathom deep; the Bed of the River, Loam or sharp and clean sandy Gravel: The Proportions of the Bridge left to Discretion. See another different*

METHOD *laid down in* PLATE XXXI. Fig. 1. *(laid down by a Scale of 5 Feet 1 Inch.)*

Represents the Section of the Coffer, and the Pier springing high, as if the Foundation had actually been laid. Wherein note, A. Bed of the River. B. Ordinary low Water in Summer. C. Construction of the Coffer, which is to hold the Stuffing, as formerly

O

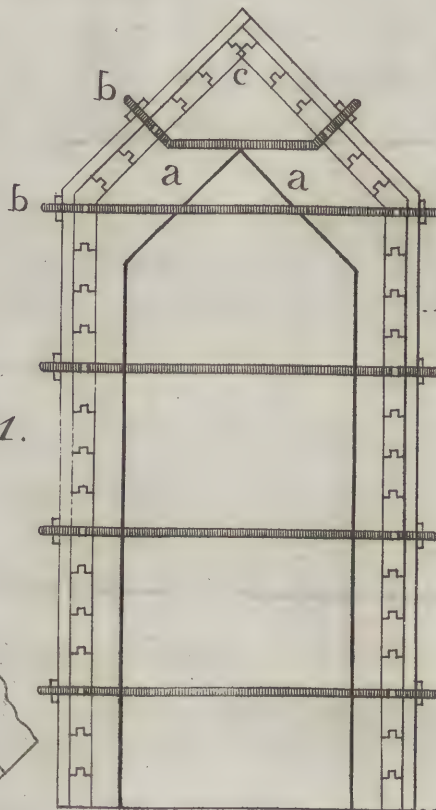
merly directed. D. One of the Brace Bars, which may be an Inch and a half square. E. Shews the Bond of the Cut-stone-work of the Pier; and F. the banking.

Fig. 2, 3 and 4, are laid down by a Scale of 1 Foot 1 Inch, and exhibits the Plans and different Views of the Piles, that are to compose the Coffin, and after what Manner they are to be pointed, which may, perhaps, require to be burnt a little in the Fire; but in these Kinds of Beds they need not be shod or pointed with Iron.

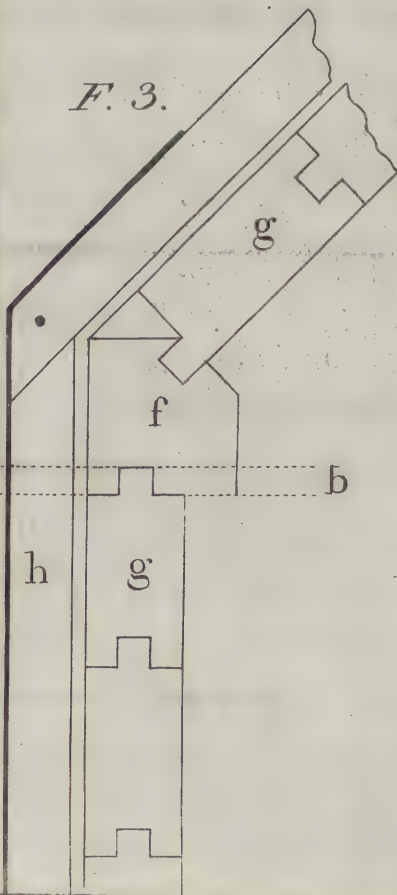
This Coffin rises one Foot above the low Water in Summer; but generally speaking, that Foot will be as if it was all under Water, according to our former Intentions. Now, the Coffin is eight Feet wide in the clear; because, had it been made exactly cubical, the Pier would be but 3 Feet, which would be too diminutive; and for this and the like Reasons, you were not to be confined, as the Proportions of the Bridge were left to your own Discretion.

There are several Ways of making what they call dovetailed Piles, three of which I have given you in Plate XV. but I prefer N^o. 4. to any other sort that I have ever seen, because it is sure, cheap and quick: the least gravelly Pebble will tear and split off the dovetails in N^o. 5. and N^o. 6. I used at *Essex-bridge*; but I found it to consume and waste a vast deal of Timber and Time, as I told you before. You see in N^o. 4. or in Fig. 2, 3 and 4, in the present Plate, the Tongue of one Pile falls into the Groove of the other. The Piles I suppose to be 12 by 6 Inches, which is thicker than what is necessary for this little Coffin; but if a slender Pile would meet with stiff Ground, it would not drive, and these will be pretty stout to bear a proportionable Force. The 6 Inches thick are divided into three Parts, two Quarters, that is Scantling of near two Inches square, forms the Groove, and another of the same Size makes the Tongue, and are all put on with proportionable Spikes, Pins or Brads. Their Connexion will be more fully exhibited by the next Plate.---Plate XXXII. Fig. 1. Scale 5 Feet to 1 Inch. Which is the Plan of that half of the Coffin that lies to the Stream, but the Stern of the Coffin may be about two Feet longer. The
Line

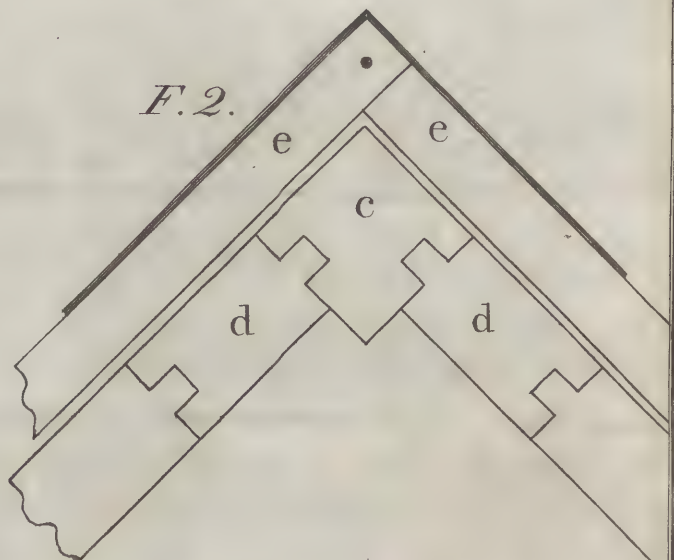




F. 3.



F. 2.



Line a. shews what Proportion of the Coffier the first Course of the cut Stone is to occupy. b. the Brace Bars.

Fig. 2. laid down by a Scale of 1 Foot 1 Inch. Wherein note, that c. represents the Cut-water Pile. d. The Piles of the Coffier. e. The Belt that incloses them, which is to be dovetailed at every Angle, and plated with half flat Bar Iron.

Fig. 3. by the same Scale. f. The corner Pile at the obtuse Angle. g. The Piles of the Coffier that go into it. h. The Belt as above, which is to be tightly braced together by the Brace Bars. b. Which in Plate XXXI. is marked D. and you there see that they are to be about 1 Foot 8 Inches below the Heads of the Piles, and level to the top of the Piles is the Surface of the Platform of cut Stones, which are to be four by two Feet, and one Foot thick each; on which Platform or Floor, the Stone-cutter begins to set the first projecting Course of the Pier. i. In Plate XXXII. is the Middle of the Bridge; and k. the extent of the Parapets.

In driving down the Piles, you must begin with the Cut-water Pile, and observe, that in the fourth Joint that you are to run a cut of your Saw across both the Tongues and Grooves, but not to take that upper Part off, 'till you are going to drop down your Belt; and you are to make the same Preparations for all the other Brace-bars; and when you are going to drop them down, rip off the upper Parts of the Tongues and Grooves to make Room for the Brace-bars.

I ought to have told you before, that these Belts must be made very slack, so that they may go easily on, and if they do not, and you are sure there is nothing in the Way to obstruct them, you must force them down with a single Maul, 'till you come to the Surface of the Water; and if you choose to put any of them lower, you must drive them the rest of the Way, after the same Manner as a Cooper drives down a Hoop.

The most of these Piles may be drove down into such a Bottom, with a single Maul, but you must also have some large and weighty double-handled Maules, especially for the corner Piles, and if the Bed proves such as we have supposed, a Carpenter, a Boatman to keep your Float or Pont steady, and three stout Labourers, may

drive at the least six of these little short Piles in an Hour, and by having fresh Men to succeed them every eight Hours in Summer Time, you may quickly dispatch the Coffers, provided, you have made proper Preparations for it as before directed, always observing to lash all the Piles you drive in the Day very tight, least an unexpected Rain should come on, and for aught you know, bring down a Flood upon your Work; and in Case you have cause to suspect a Flood, brace your Cut-water Pile with temporary Braces, in the same Manner of a. b and c. in Plate XXIII. and from thence disperse the Braces to the right and two obtuse Angles of the stem of the Coffer.

S E C T. II.

PROP. V. **I***T is required to build the Piers for a Stone Bridge, in a smooth fresh Water River of sixteen Feet deep, the Bed of the River Loam; the Proportions of the Bridge left to Discretion, as before.*

M E T H O D *laid down in PLATES XXXIII, and XXXIV.*
Scale 5 Feet 1 Inch.

PLATE XXXIII. Fig. 1. Section of the Coffer. Wherein note, A. The Bed of the River. B. Ordinary low Water in Summer. C. Section of the Coffer. D. Section of the Pier springing high, standing on the Platform or Floor of cut Stone. E. The Bank to be of the same sort of Materials of the Stuffing, Lime only excepted.

Fig. 2. is laid down by a Scale of a Foot to an Inch. Wherein note, a. Is part of one of the Piles that compose the Coffer, having the Groove ripped off the upper Part of it, to receive the Brace-bar. b. Part of one of the Belts that surround it. c. The Nut that screws it tight together. d. The Screw. e. The Brace-bar fallen down into its Place, and is to be keyed under the End of the Screw-bar, d. in which there is to be an oblong square Hole made to receive it.

Pl. 33.

D

F. 1.

E

B

C

f

A

F. 2

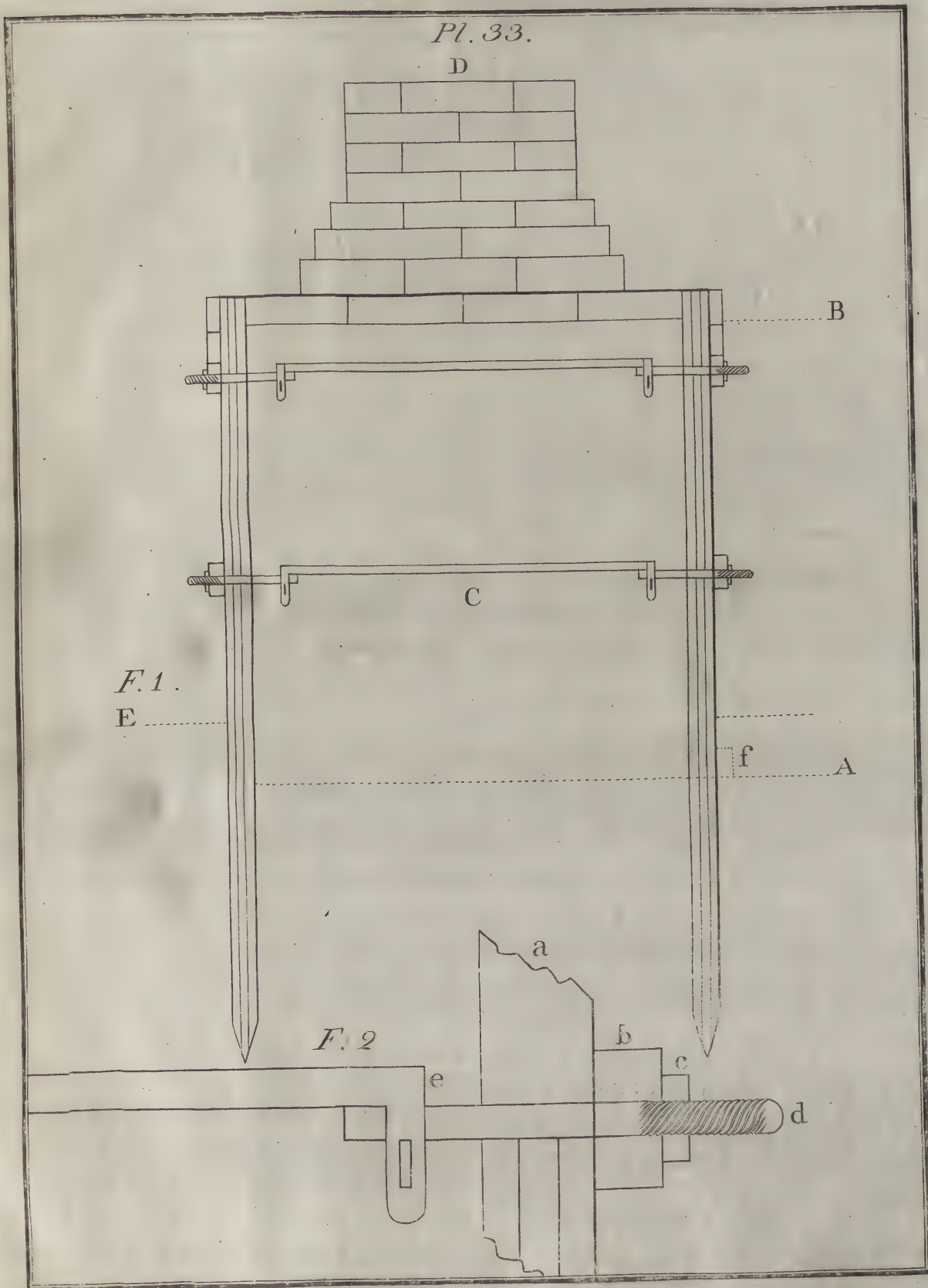
a

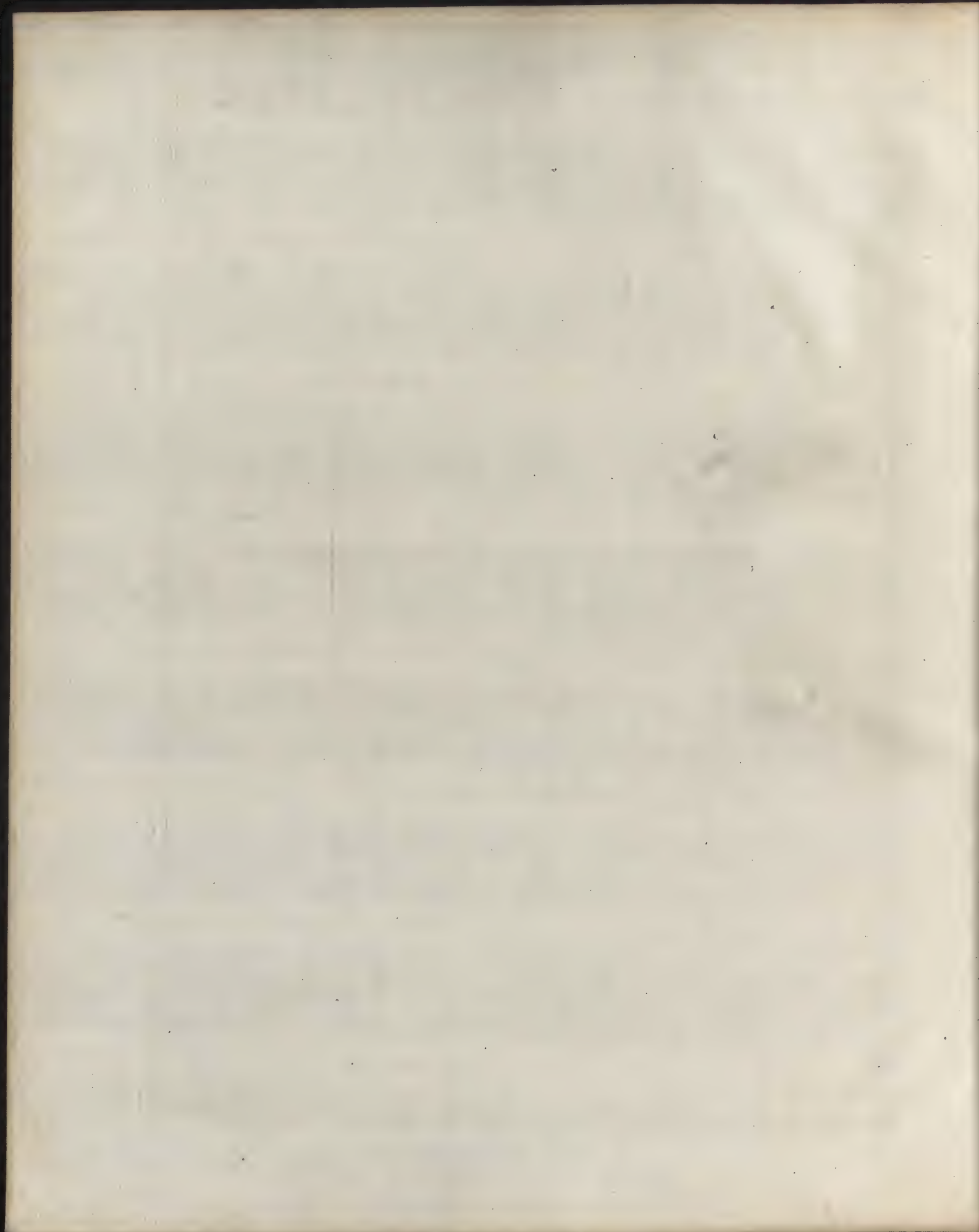
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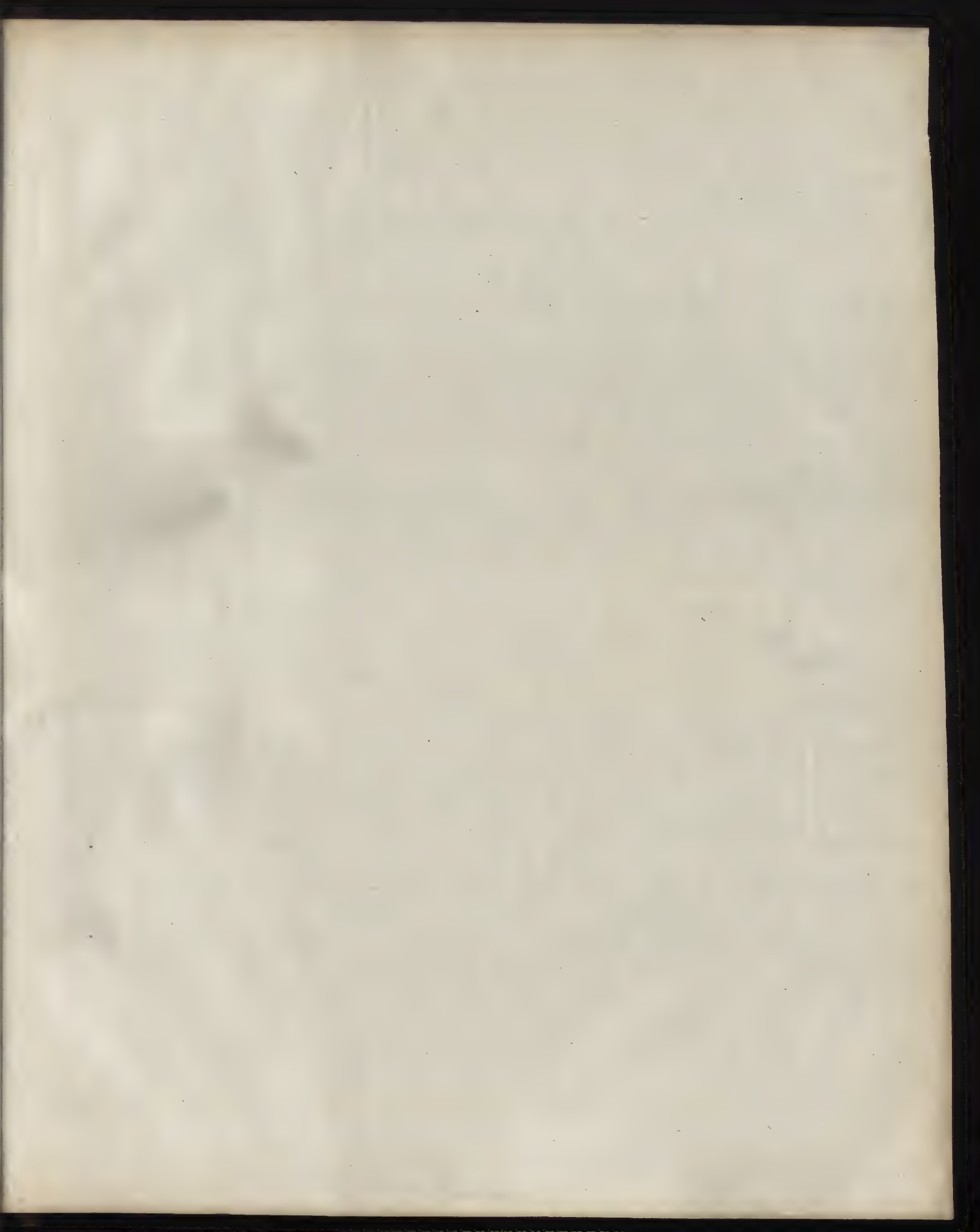
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e

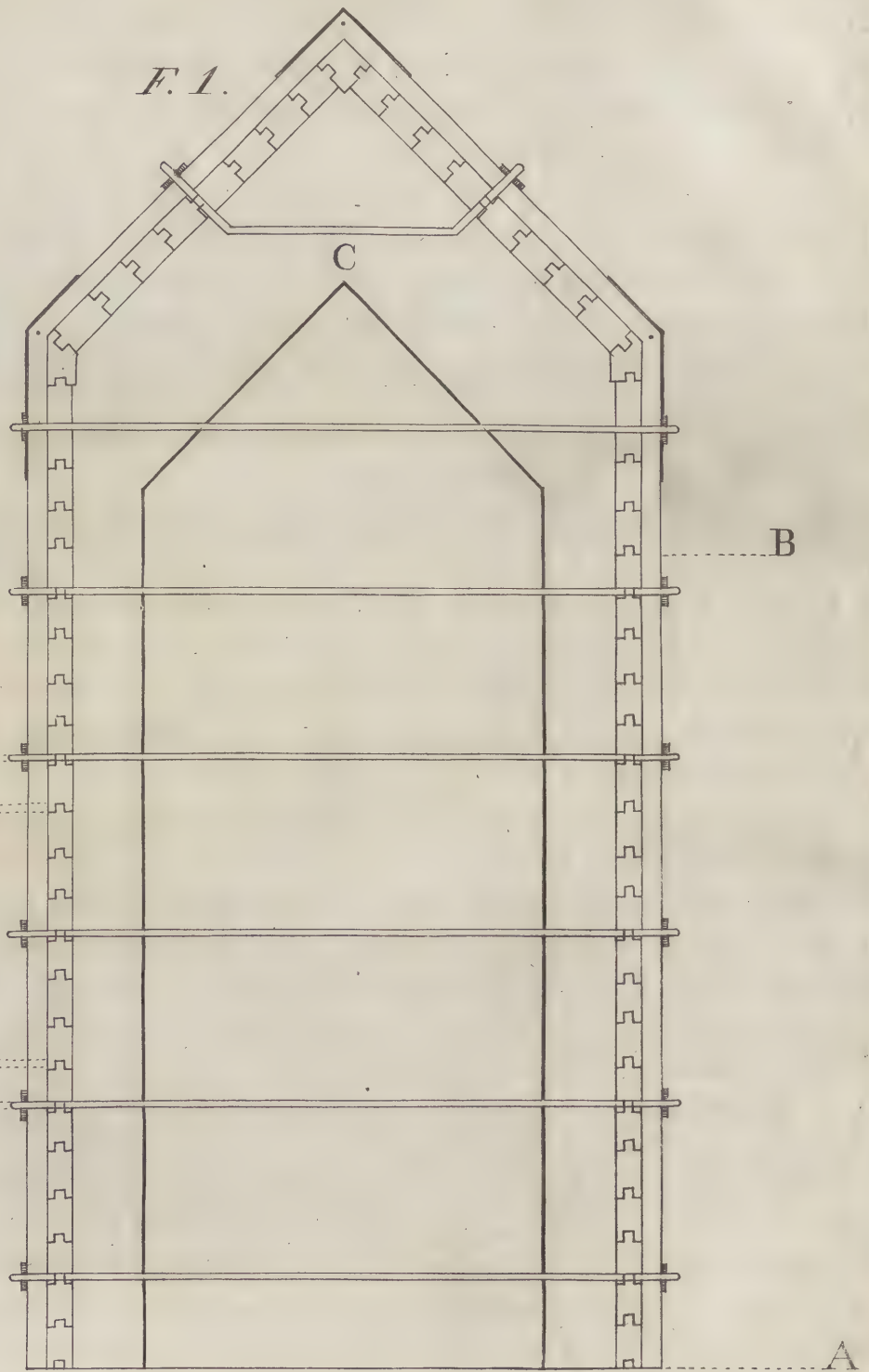
d







F. 1.



F. 2.

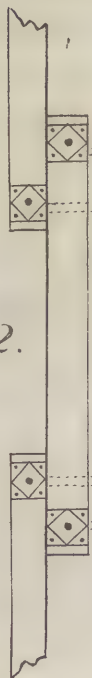


PLATE XXXIV. *Scale 5 Feet 1 Inch.* Is the Plan of the Coffers for one half of one of the Center Piers. Wherein note, A. Middle of the Bridge. B. Outside of the Parapet, which from out to out is 47 Feet. The Center Arch is to be 48 Feet span. C. First Stone of the Cut-water in the first projecting Course of the Pier.

It may perhaps happen, that you may meet with some Difficulty, by fixing your Chain-braces so exactly, as to fall directly into the Joints appointed for them, and also, in splicing the long Sides of the Belts, so as they may not wreck in dropping them down; and if you apprehend that, then follow the Method laid down in Fig. 2. which shews how the Belts are to lap and break Joints, by which you will remove all the Difficulties, and make the Coffers extremely substantial, by dropping down your Brace-bars in pairs, as you see in this Figure drawn horizontally.

But I must give you a Caution, with regard to your stuffing this or the like Coffer. If you have a Bed of sharp, clean sandy Gravel, your first Stratum ought to be plenty of Roach-lime, in order to cement and petrify that Gravel, and then proceed with the rest as formerly directed; but in Case your Bed should happen to be fine, quick Sand, or soft spongy Ground, notwithstanding your piling the inside of your Coffer at 2, 3 or 4 Feet asunder, yet, in some Cases it may be very necessary, before you put in your Chains, to make a Belt pretty large, and drive it down (as I told you Coopers wrought) to the Bottom of the Water, as f. in Plate XXXIII. and that will keep all tight together below, and the banking, E. is to extend from Pier to Pier, and ten Feet above, and fifteen Feet below the Point of the Starlings of the Coffers, which will there make a firm new Bed for the River.

I recommend it to my young Reader, to bend his Attention to the Methods fully laid down in this and in the last Propositions, and principally exhibited in Plate XXXI. as I am convinced, that it may prove very useful not only for building in Water, but also in quaking Bogs or Morasses, that have smooth penetrable Bottoms, but especially Loam or soft Clay. Remember then, when you are engaged in such Works, in a still or gentle running fresh Water, quaking Bog or Morass of a moderate Depth, that you may make
effectual

effectual Coffe-dams, by driving down such Piles as these, answerable to the Intention and Size of your Work; only observing, that in forming the Angle, it will not be necessary to make use of such gross Scantling, as represented in Plate XXXII. Fig. 2. letter e. Because Scantling of the same Size of d. d. will answer effectually, by pinning and spiking the Grooves on the corner Pile, and the Tongue on the next returning Pile, and all their Heads may rise two or three Feet above the Surface, and there they may be cut off level, and a Ribbon run a long the outside of them, from whence you are to dovetail strait Beams or Braces of small Scantling to keep all tight together, whilst you have Occasion for them; and when all that is done in a Workman-like Manner, then get the Water, Slough or Mud taken out, corking any Leakages that may happen to appear according as the Water sinks; and when you have thus got the Coffe clear, strengthen the Bottom by driving down square Piles, or by laying a Grillage of Timber on it as before directed, and thereon let the Masons go on with their Work after the usual Manner; and when they have brought up their Work to a proper Height, these Piles that composed the Coffe are to be drawn out, and applied to another Pier or Part of the Work.

Single Rows of such Piles, may also be extremely useful, in preventing or stopping subterraneous Leakages or Ouzings under Coffe-dams, Dikes, Sluices, Flood-gates, Wires, Canals, Mill-races or the like; and likewise an excellent Method to preserve and to keep in the Ground that is under the Piers, either of a new or what remains under an old Bridge, provided they can be drove down, for these will take very little Room off the Water-way, and will be exceeding tight and close tongued and grooved into one another, which is much better than any Thing that can be done by square Piles. In short, I cannot express the great Advantages which I apprehend, may accrue or be deduced from this Method.

But in many Cases it may be necessary to drive two Rows of these Piles, leaving a convenient Space between them, which is to be filled up with good and well rammed Clay, and that will unite with the Bottom, and make exceeding staunch Coffers, or would
also,

also, effectually enable you to make staunch dry Docks, particularly where several of them are ranged contiguous to one another, either in Tide-rivers, or within an inclosed Harbour in the Sea.

SECTION III.

Concerning the building of Stone Piers, in a deep Tide-river, on a hard rough Bed.

I HAVE already observed, and every Body may know, that there is a vast deal of Difference between the various Natures of the Beds of Rivers; and for that Reason we must invent such Methods, as are capable of being varied in such Manner, as may make them suitable to our Purposes; but as I aim at Conciseness, I shall neither perplex you with a Multiplicity of Propositions, nor deprive you of sufficient Room to exercise your own Ingenuity; and therefore, I shall State my next Proposition, so as to comprehend some of the most extraordinary and difficult Circumstances.

PROP. VI. *Let it be required to lay a sure, quick and cheap Foundation for the Piers of a large Stone Bridge, in a specious Tide-river, greatly exposed to the Agitations of the main Ocean, the Bed of the River exceeding hard and rocky; in the Middle of which, there are six Fathom deep of low Water, whence the Bed rises gradually on both Sides; the spring Tides sometimes rise four Fathom more; the Size and Proportions of the Bridge, left to Discretion.*

METHOD, *see* PLATES XXXV. XXXVI. XXXVII. XXXVIII.

In which I pursue the Methods pointed out by the first three Propositions. PLATE XXXV. Scale 30 Feet to 1 Inch. Wherein note,

Fig. 1. Represents the Platform of the Coffers, for one of the Middle Piers in two separate Parts, with the Plan of the Pier upon them.

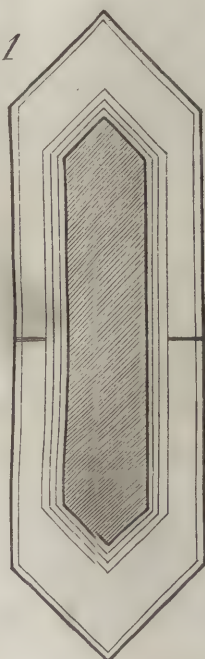
Fig. 2.

Fig. 2. Exhibits the Elevation of the Coffers, with the Pier springing high. Wherein note, a. the natural Bed of the River, suppose then, at the Distances of b. b. you are to drop down Stones (none of them need be above a hundred Weight) in two direct Lines across the River, by which you are to make two Stone Dikes or Banks, of 12 Feet high or more, these Stones are to be of all lesser Sizes down to sandy Gravel; and then you are to proceed and fill up the Pit, that these two Dikes or Banks will form to the level Line, c. c. with very small Stones, Gravel and Sand, and as much Roach-lime as you can conveniently spare for it, always observing to throw the largest Part of it next the Stream of Ebb or Flood, and at other Times you may convey it by large wooden Troughs fastened to the Sides of the Gabbards. This Line, c. c. is the Bed or Scite of the Coffers, and may be made higher or lower as other Circumstances may require. And according as the Coffers are settled in their respective Places, or at any other Time when you find it most convenient, you may go on with banking or filling up the Pit after the same Manner, till you level it to the Lines, d. d. The low Water mark is e. And f. represents the Breadth of the Bridge from out to out of the Parapets, 54 Feet. And the Center Arch is to be 84 Feet span, as you will see more particularly delineated in the next Plate.

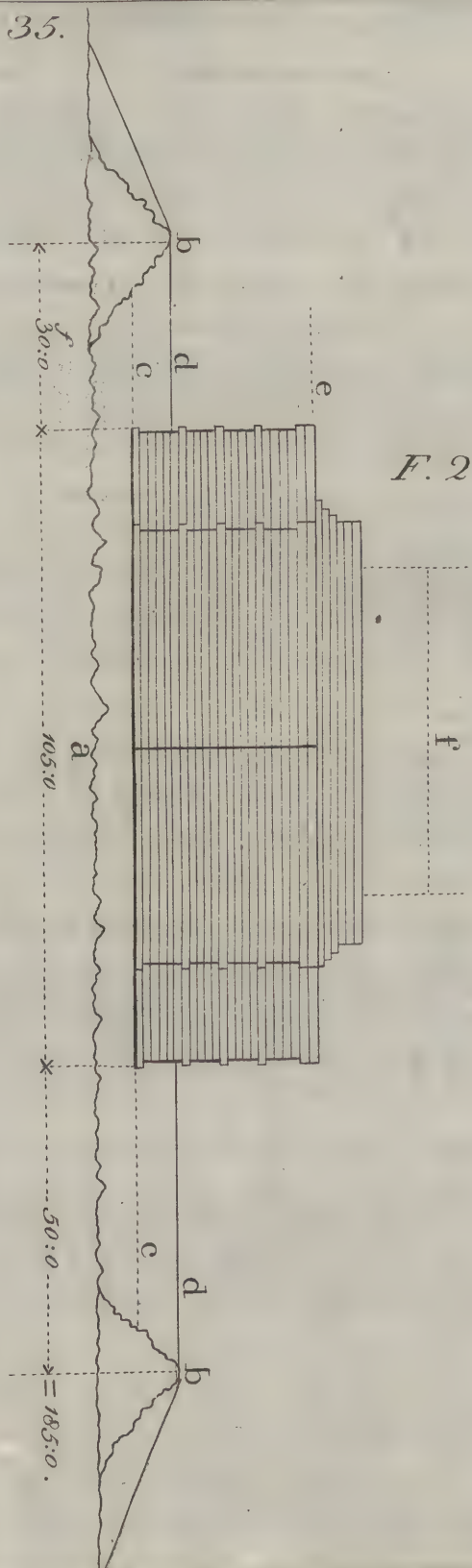
Plate XXXVI. by the same Scale, gives you the principal Lines of the three Middle Arches. Wherein note, that a. is the natural Bed of the River. b. The Bed on which the Coffers are to stand. c. The Bank or artificial Bed of the River, as before mentioned. d. Low-water, and e. High-water marks. f. The Pavement.

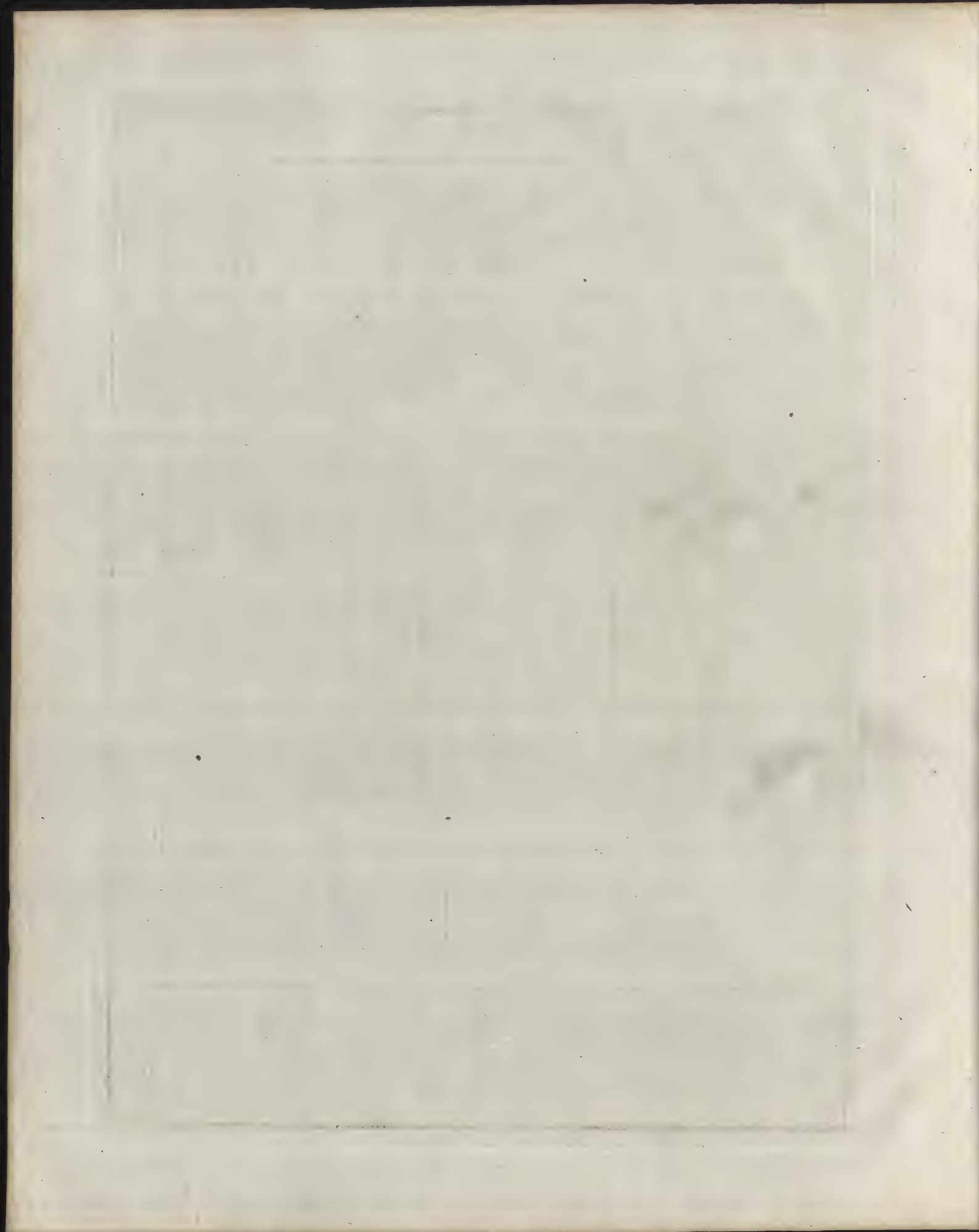
I do not doubt but some Readers may object, that thus raising the Bed of the River and these large Coffers, will dam and obstruct the Current. In answer to this, you may be very well assured, that in all deep Rivers, the Current runs principally, and with the greatest Velocity toward the Surface of the Water, and consequently, those can only increase the Celerity, but cannot obstruct the Current; and in some Degree, this is also the Case in all Stone Bridges, and therefore, that Objection can have no Weight, because, it is evident, that no disadvantageous Conclusions can be drawn

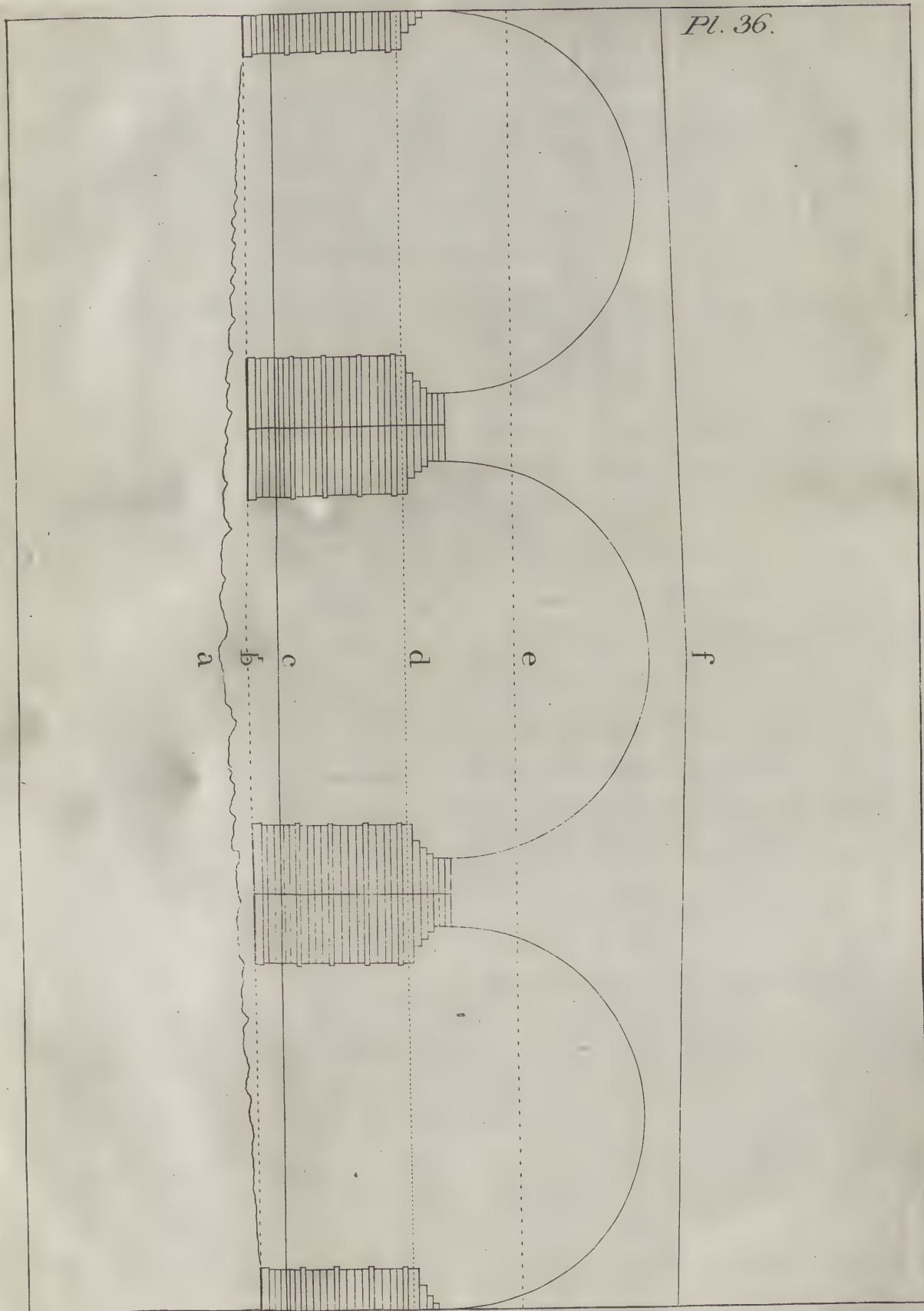
F. 1



F. 2









drawn from it, even were the Bed raised to four Times that Height.

But from these Observations you may also collect other material Remarks, that perhaps, may prove instructive and useful to you in several Respects, concerning the Motions and Velocity of Rivers. As for instance, Suppose that for some particular Purpose, you are required to calculate and to make a just return of the daily Quantity of Water any small River may produce during the Summer Season. Observe then, that previous to that Calculation, you are to make strict Enquiry, and to make yourself thoroughly acquainted with several Parts and Places in that River, and in all those Parts and Places to take correct Sections and Plans thereof, on which you are to lay down your Depths or Soundings, strictly observing the Surface and Declination of the Bed, and the Declivity and Irregularity of the Banks; and note, that the Friction that arises from these, greatly contribute to lessen the Celerity of the Water.

The Thread, that is, the Middle of the Current of the River, runs the freest, and is the least retarded by those Obstacles; and that Thread, especially during the Time of a Fresh or Land-flood, is always to be found nearly over the deepest Parts of the River, and those deepest Parts are very variable, and produced according as the Declivity and Circumstances relative to the Bed and Banks may direct; and in dead or slow running Water, this Thread cannot be discovered by the Eye; and therefore, for these Reasons, I say, you are to make yourself thoroughly acquainted with all the Parts and Places, where you intend to take the Velocity or Celerity of that Water; that is, how far it runs in some certain stated Time, which is to be done by straining two parallel Ropes or Lines, across the River at certain Distances from each other, strictly observing, how many Minutes or Seconds a Bit of Cork or some other such light Matter will take to run a certain Space, which you ought to try near each Bank; and also, in the Middle of each of those Parts or Places of the River, also strictly observing, whether or no, they are hastened or retarded by the Wind; and so, after summing up all together, you may be enabled to calculate the true Velocity on an Average, and thereby compute and measure

P

the

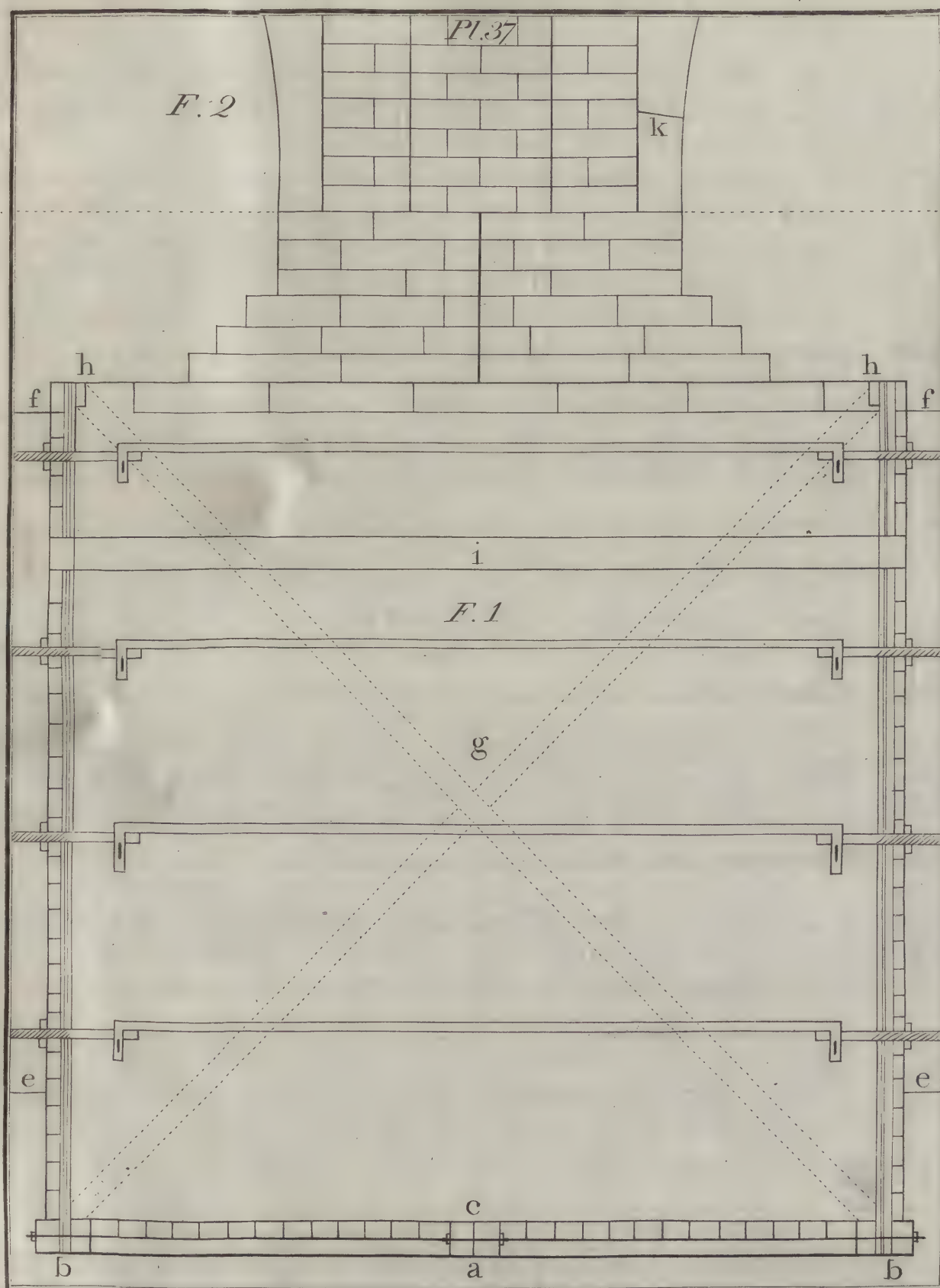
the cubical Feet of Water, that you may reasonably conclude to pass through and may be produced by it in the Time required, making rather large Allowance for waste, &c.

There have been numerous Persons involved in very serious and disagreeable Circumstances, both of private and public Natures, on the Credit of such Calculations as these; especially, where they have much exceeded the Truth, and thereby destroyed and rendered hopeful Schemes abortive, that might perhaps, otherwise have been attended with private and public Utility.

Hence also, you may conceive some useful Ideas, concerning the Motions and Velocity of Rivers in general, but distinguish and remember, that rapid Land-floods roll down and principally acts from the Surface to the Bottom in all deep Rivers, as I hinted above, and that when a Flood Tide flows into the Mouth of a River over a shallow Bar, it operates from the Bottom to the Surface, by damming up, and totally overpowering all the fresh Water that comes within its Influence. But to return.

Now, I hope, I have furnished you with general Ideas of the Nature of the Works, which you are going about; let us in the next Place, consider the Construction of these Coffers. See

PLATE XXXVII. *Scale 5 Feet to 1 Inch.* Fig. 1. Represents the Section of the Coffer; but observe as before mentioned, that this Coffer would be too large to be made in one, and therefore, I propose, that it be made in two separate Parts. Whereon note, that a. is the Bottom. b. b. The double Sills between each pair of them; the upright Planks that compose it are to be placed erect, and are to be the Tenons of the Hull, and then they are to be pinned and bolted together. c. is the Keel or Middle Sill, and as probably you cannot get Timber long enough for them, you must run a breaking cut through the longest you can get, scarf them to fit your Length, and turn them End for End, and bolt them firmly together with Nuts and Screws; between these, you are to grate the Bottom with two Courses of six Inch Plank, crossing one another. Both the upright and horizontal Piles of the Hull are to be tongued and grooved as in Plate XXXI. Fig. 2 and 3, and all of them to be pinned together at their Intersections, and all the out-ward





ward or horizontal Piles are to be dovetailed at the Angles, and there plated with whole flat Bar; and there are to be five launching and hauling Rings at the three right and two obtuse Angles of each Semi-coffer, (as formerly directed in Plate XXX. letter a.) e. is the banking or artificial Bed of the River, which you see rises 6 Feet high all round the Coffers, represented by c. in the last Plate. f. Low-water mark. g. Temporary diagonal Braces, to prevent its warping in launching. You see these Braces have a Bears Mouth upon the upper End of each, and are to be fitted and nailed to the Ribbon, h. and when the Coffers are stuffed about two or three Feet high, they are all to be knocked off, as of no further use.

Though I have drawn the four Tiers of Brace Bars to be made of square Iron, yet if it is as convenient to you, I would rather advise you to make use of small Boom-chains for that Purpose; but use which you will, it may be advisable to strengthen them with the six Inch Plank, to go quite through, and to be dovetailed at each End, through the Hull that is through the upright and horizontal Piles; and you may observe in Plates XXXV. and XXXVI. that I have only belted the Hulls as before, but on second Thoughts, I think it the surest Way to let them lie as close to one another as they can, and so I have represented it in this 37th Plate, Fig. 1. which makes the Hull 12 Inches thick throughout.

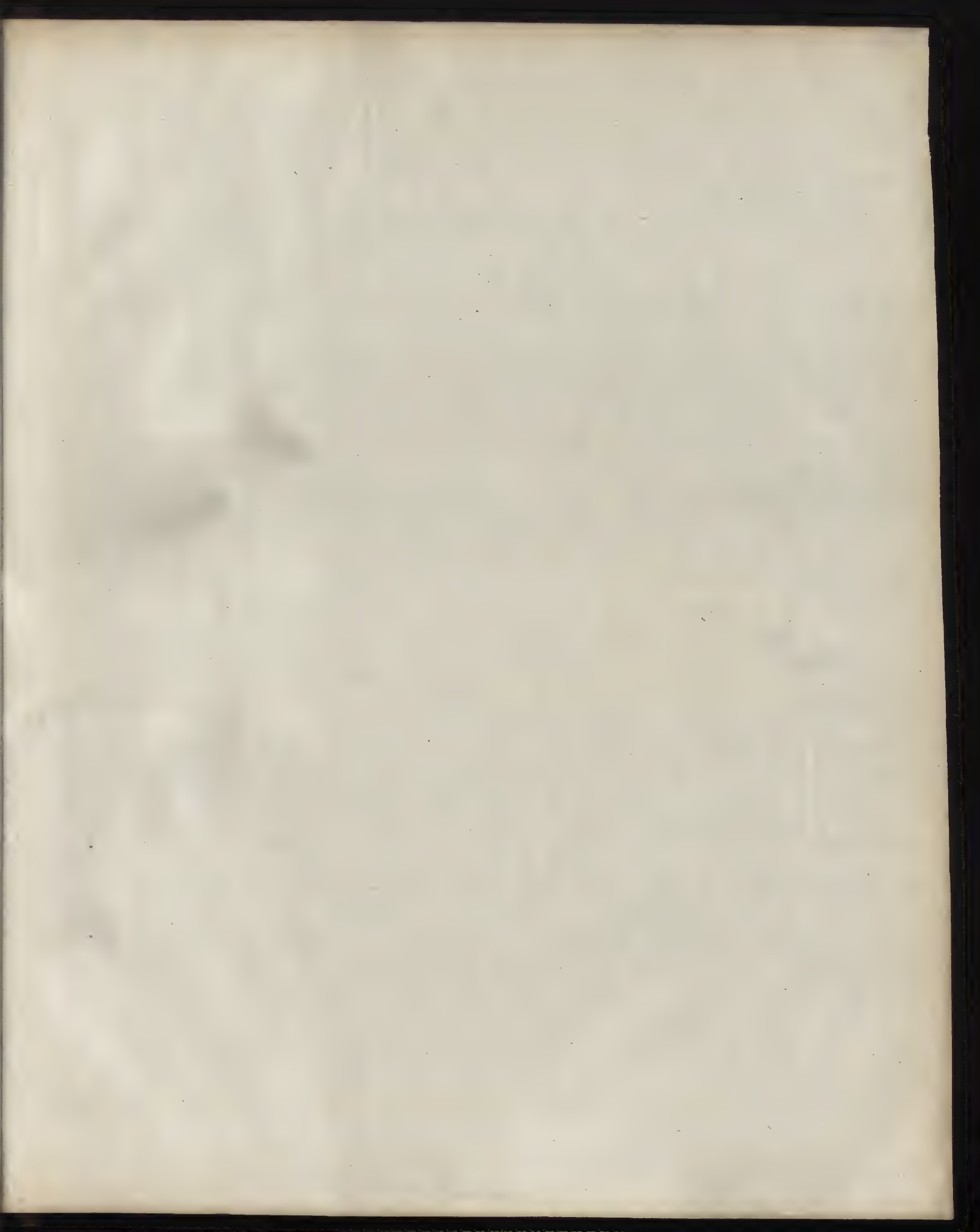
Fig. 2. Represents the front of the Pier standing on the Platform, or Floor of Cut-stones, which covers and incloses the stuffing of the Coffers, which must be run Home to the Hull of the Coffers, when the Ribbon h. is taken away.

You see, for the Reasons before given, that I keep as near as the Bond of the Work will admit, to have the Stones of the Scantling of 4 by 2, and a Foot thick; and if you carry up the front of the Octagon in Ashler, they will answer effectually, but if in Rustic Work, each Course must be about 2 $\frac{1}{2}$ Feet high, including the Chamfers, and k. is the Height of the Arch Stones, the which if rusticated also, the Chamfer must run through the whole Soffeto of the Arch; but all this is beyond our present Purpose; let us therefore, return to the finishing of the Coffers. See

Plate XXXVIII. *Scale 5 Feet to 1 Inch.* Fig. 1. Represents the respective horizontal Situations of the Chains, and the rest of this Figure shews you the Surface of the Cut-stone Floor, that is to finish the Coffin within the Hull. Fig. 2. Shews you the Scite of the three projecting Courses of the Pier, and the third Course of the Body of the Pier, and the Bond of the Work in that Course. In these six Courses, that together carry you to the springing, there may be three of the Courses chained with two Inch square Bar, sunk quite down into their respective Courses, and run with melted Lead as usual.

I have already advised that all the Cut-stone Floor, or Platform, is to be carefully and closely set in swimming Beds of choice good Mortar, and all the Joints with Tarrafs Mortar, and if you do not think that sufficient to withstand the Effects of the Water, you may at any Time afterwards scrape the Joints clear for about two Inches deep, and either fill them with melted Lead, or rather cork them with the shavings of Lead, but only for so far, as exceeds that first projecting Course. The seven strong Lines, d. represent the Cramps, that are to cramp the Hull and the cut Stone Floor together, which you will hereafter find more fully described; only observe, that they are to be lodged in the second Course of the Stone.

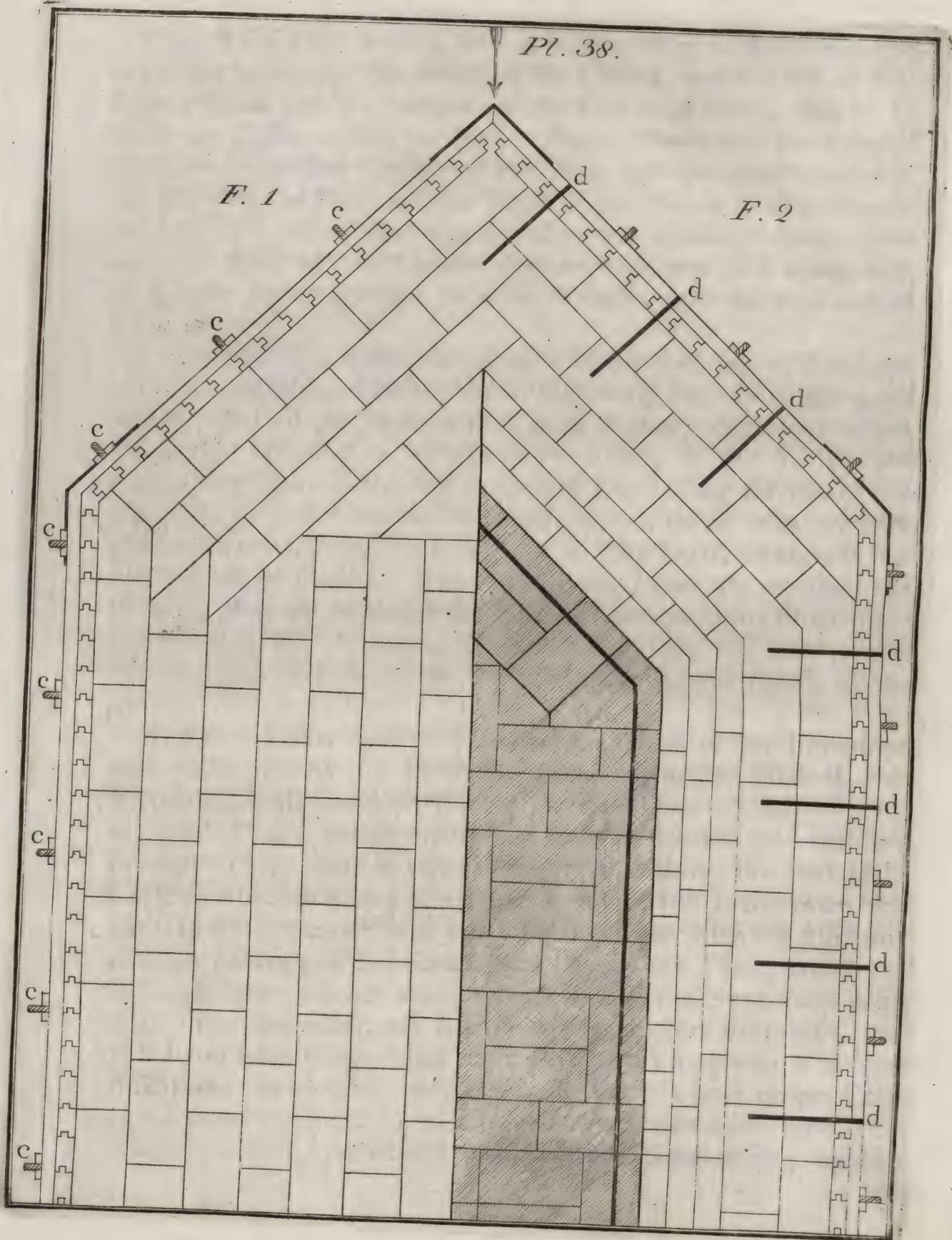
And now I have furnished you with an Idea of my Intentions, pray point out any one individual particular in this Method, that is attended with the least Degree or appearance of Impossibility, or even of any extraordinary Difficulty. Surely, you will not pretend to say, there is any Difficulty in making the two Half-Coffers, which may be put together by a very few Journeymen Ship and House Carpenters, and a few Black-smiths, with the Assistance of a few Sailors and Labourers, in a Fortnight's Time; and if you are required to use any extraordinary Expedition, you may easily have them launched and stuffed within another Fortnight, provided you take proper Care to have every Thing you will want timely and conveniently provided, and that you have proper Crafts to carry in your stuffing, which by the Assistance and Direction of your ten-buoy Ropes belonging to your two Semi-coffers, the Men
may



Pl. 38.

F. 1

F. 2



may work at low or high Water, either by Night or Day, according as you find necessary; and if this Coffer can be stuffed within a Fortnight, pray might not another set of such Men do the like Work within the same Fortnight?

Let us now compare small Things to great ones. We are very well assured, that *Apollodorus* compleated *Trajan's* Bridge within the Summer of the Year of our Lord 104, and that the ten outward Piers were built on artificial Foundations, made by wheeling in vast Quantities of large and small Stones, and other filling (perhaps like the stuffing so much used by the Antients) but by all my Industry I could not find out, by what other Methods he made the Foundations in the Middle of the River. Now if I was to presume to enter the List of Conjecturers, along with some great Folks, I should conclude, that the Methods he took to build the inner Piers were, to rise or bank up the Bed of the River (of which you shall hear further) and to set such Coffers as these thereon, and from thence proceed with the Stone-work as usual; (and I have already told you where to find the true Methods which he must actually have taken) and if the Foundation of one Pier can probably be carried up to low Water mark in a Fortnight, could not twenty such sets of Men, do twenty such Pieces of Work in the same Time? And if so, where is the Wonder that *Trajan's* numerous Army compleated that Work within that Time? Nor need you be afraid to compleat such an one as we are now projecting, we will suppose of 19 Arches, even within the compass of the six Summer Months, if there was a Necessity for it, and Money sufficient to carry it on, provided you had sufficient Time, and you had previously provided and prepared every Thing you wanted for the Purpose, before you launched your Coffers.

SECT.

S E C T. IV.

*Concerning Bridges principally contrived for the Use of LONDON-
DERRY, WATERFORD, and WEXFORD, and for such other large
and deep Rivers.*

THROUGH the Course of my Endeavours to contrive and find out effectual Methods for building Bridges and other Works in deep Waters, *Londonderry, Waterford and Wexford*, (each of which I have viewed) have constantly enjoyed a prime Place in my Mind; and being thoroughly acquainted with many intolerable Disadvantages, that not only the Inhabitants in, and the Proprietors of those and the adjacent Places, but the Public in general daily sustain, through their want of Bridges; these Considerations alone, have excited my most zealous Endeavours to find out proper Methods to redress those Grievances, and not in those Places only, but in many others in like Manner; and with that Intent, I here freely transmit and communicate to you my Sentiments and Ideas on this important Subject. And I am sure that they are considered, and well weighed to the utmost extent of my Capacity, and that they are not only practicable, but by a prudent Application of what I am now laying before you, may be productive of immediate Utility, and answer according to the Appellation bestowed on them, of being sure, quick and cheap Methods, for those and the like salutary Purposes.

The Conciseness of this Work, and not being able to procure proper Sections of those Rivers, prevented my laying them down particularly, nor have I formed any Design exceeding six Fathom low Water; but I hope they most clearly point out, Methods for building in a much greater Depth. As for instance, let us suppose a River of fifty Feet deep at dead low Water, and let us examine, after what Manner our general Rules must conduct you to draw Designs for that Depth. The principal of which directs, “ that the Coffers should at the least extend to a Cube of the Water
“ they

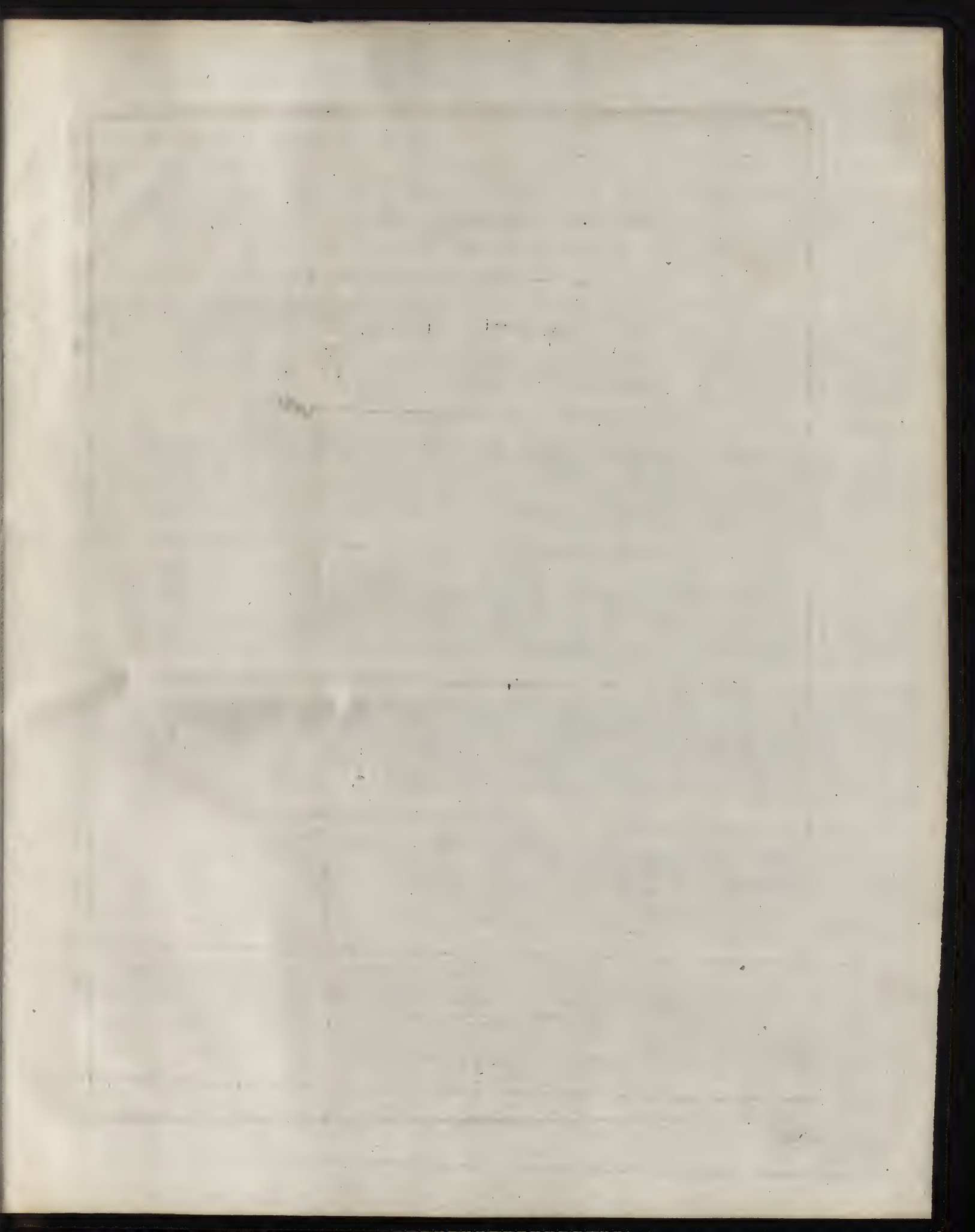
“ they stand in; and that the Size of the Bridge ought to bear
 “ some Proportion to the Depth of the Water in which it is to
 “ stand.” Now if the Water be 50 Feet deep, the Coffer must
 at least be 50 Feet broad, the naked Body of the Pier 25 Feet,
 and consequently the Arch must Span 150 Feet. I grant that such
 a Span would not by any Means answer for our poor Country,
 because the Expence would rise infinitely above any Thing
 that we could have the least Hopes of accomplishing. Now to
 remedy this, the Method is obvious, turn back to Plate XXXVI.
 and observe the Line b. which is the Scite of the Coffers and distant
 from a. but six Feet, which is placed in the Middle of the River.
 Now, we must suppose a. to be 20 Feet beneath b. and let a. be
 supposed to lie as far as you please either to the right Hand or to
 the left, and let a. and b. be either more or less than 20 Feet; the
 Method is, to raise up and make an artificial Bed of the River,
 with such small Stones and Gravel as formerly directed, till you
 bring it to the Line b. and to extend it in Breadth on the Bottom
 in Proportion to its Height; and then every Thing else will fall
 in, in due order. Hence it is evident, that let the Depth of the
 Water be what it will in Moderation, the Rules may help to
 conduct you in drawing Designs for any other reasonable Depth.

But perhaps, after all I have said, you may object, that this
 banking or artificial Foundation would not be sufficiently strong
 for the Purpose.

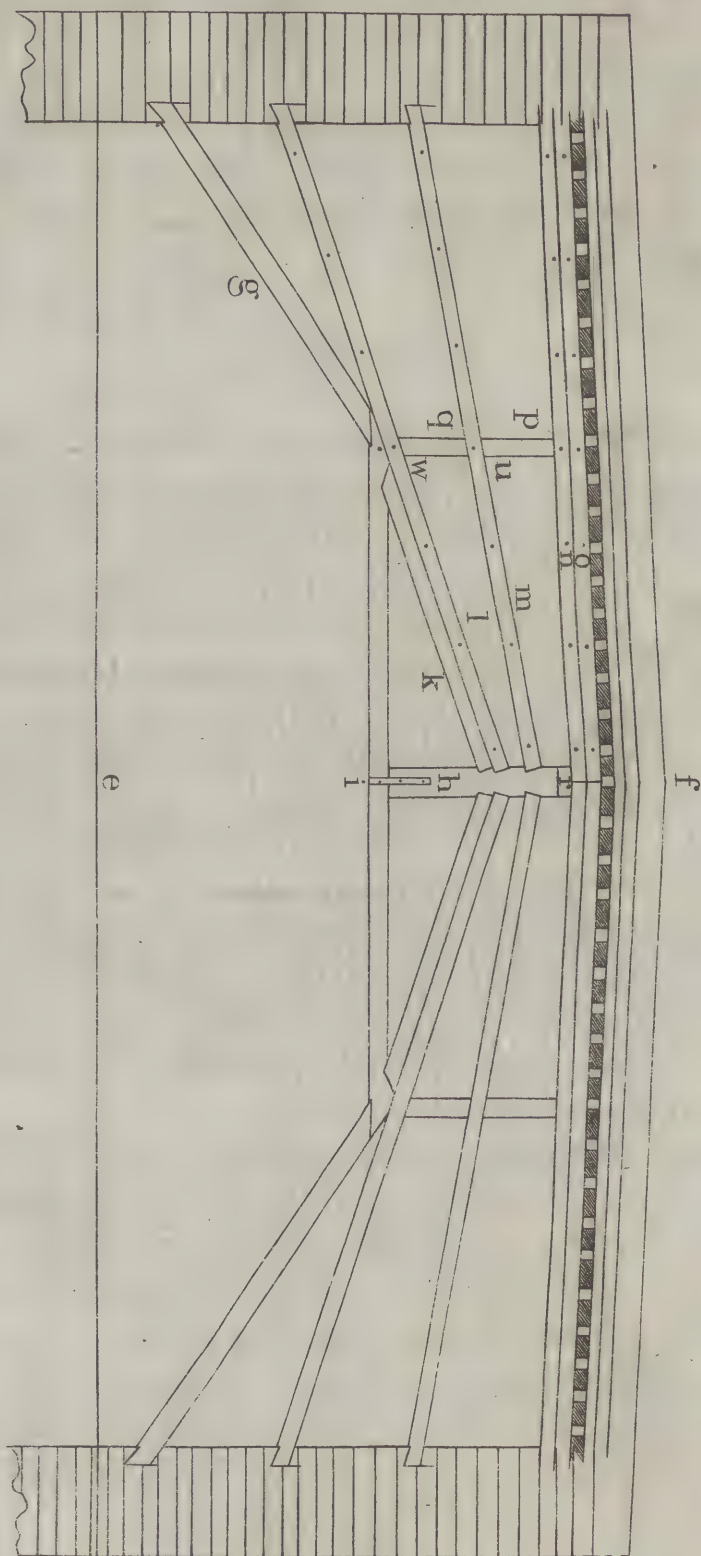
You have been repeatedly informed, that in building *Trajan's*
 Bridge, *Apollodorus* had “ the ten outward Piers built on an
 “ artificial Foundation, by wheeling in vast Quantities of large
 “ and small Stones, and other filling, after the usual Manner of
 “ carrying a Mole into the Sea.” --- Let us here observe, that our
 Historian says, “ after the usual Manner of carrying a Mole into
 “ the Sea.” And that notwithstanding those Rivers are greatly
 agitated at some Times by the Sea, yet not liable to be quite so
 much so, as “ a Mole projected into the Sea,” whose Surface is
 exposed to the Waves of the Ocean. Therefore, it is evident, that
 if this Method was sufficient for such an enormous Bridge, surely
 there cannot remain the least Objection against the Stability of ours.

But

But pray give me leave to engage your Attention in a more particular Manner. It must be admitted, that this Country cannot afford to carry on any expensive or very sumptuous Work for want of Money; but if we have a Scarcity of Money among us, I am confident, that we have such very great plenty of small Stones and Gravel, that in every navigable River in this Kingdom, you may be abundantly supplied with these common and in a Manner insignificant materials, and together with the Labour of a few Gabbard-men and Labourers, such an artificial Foundation may be accomplished at a very small Expence; and that either of those three Corporations, with the aid of some of the principal Proprietors adjacent, even in Case they got no help from the Public, need not in the least be afraid of completing such a Work. And as these common Materials can be so easily procured, it will consequently follow, and the least Degree of Prudence will direct you to raise the Bed of the River as high as you think convenient with these cheap Materials, in order to save Labour and other Materials that would prove infinitely more expensive. And thus reducing the Depth of the low Water, perhaps to eight Feet, allowing four Feet of that for the Banking, and four for the Navigation; you are thereon to build the Bridge, according to the Plans and Methods hitherto and hereafter exhibited, or according to any other Proportions, that you may think most agreeable to their respective Situations, paying due regard to the Heights of the Banks, Quays, &c. and particularly observing, that the higher you raise the Bed, the less Money you will require to build the Bridge; but I say you must pay due regard to the Navigation of the River above the Bridge, for if you leave low Water deep enough for that Purpose, you need not scruple in some Rivers, to raise the Bed so, as to reduce that Part of River to a perfect Ford, which all People search for that are concerned in the like Work, and which, you may make perfectly substantial, if you adhere to our former Conclusions. Therefore, if Nature has not provided a Ford agreeable to your Purposes, you may have it in your own Power to supply that by Art, which you find you cannot enjoy by Nature. Hence you may also deduce an excellent Method of making or rendering a dangerous Ford, much
more



Pl. 39.



more safe for Travellers, even for Carriages of any kind, and the Expence will be but a Trifle to a County, where they might not be able to build a Bridge.

These brief Considerations, I thought previously necessary to prepare you to form a clear Conception of the particular Methods which I have contrived for, and I advise you to lay them before the Gentlemen of your Committee, but that shall be the Business of the next Section.

S E C T. V.

On an exceeding cheap, and most substantial Method of building a Bridge, in a very deep and spacious River, which may be grafted on any of the former Methods.

HAVING fully proved and demonstrated on the six Propositions, so far as the Nature of my present Design requires, that these are eligible Methods to build Stone-bridges in deep Rivers; it is incumbent on you to make yourself thoroughly acquainted with these Matters, and to apply your Attention and the utmost extent of your own Genius, to consider and improve them according as you find it necessary: And after all, you may probably find yourself far short of Arguments sufficient to satisfy every Member of your Committee, which are generally composed of Gentlemen of various Abilities; some of whom, may perhaps, readily conceive and approve of what you offer, but others, may differ widely from them. In this Case, I advise you to enquire among your Acquaintances, and take Notice yourself, which of the Gentlemen seem to be best acquainted with the surprising Performances of the Antients, in Works of this or the like Nature; for some of these will be the most likely to support your Arguments, and this may incline the Majority in your favour. But suppose you fail herein, I have still a powerful Argument which cannot fail of meeting with the Attention of the Board, *viz.* that you should proceed with your Coffers, by either of the Methods

pointed

pointed out in the last Section, which will bring your Foundations, that is the Lip of the Hull, one Foot above the low Water mark, as represented by d. in Plate XXXVI. and thereon erect Piers either of hewn or rough Stone, or both just as they agree, which would sufficiently answer your Purpose, and which you may begin upon the Platform, Plate XXXVIII. Fig. 1. But it would do best to begin them on the springing Course, represented in Fig. 2. and also in Plate XXXVII. Fig. 2. and thereby to make a substantial temporary Bridge with Timber, at such a trifling Expence as would not be worth Notice, in Comparison to what it would cost, if done in any other Method that I have ever heard of.

This Thought when first suggested, actuated by the Motives before mentioned, actually carried me beyond the Limits of my former Intentions, which related to laying Foundations in Water only. However, I indulged it so far, as to endeavour to furnish you with a Design of such a temporary Bridge, as may perhaps, fully answer the most sanguine Expectations of your Board and the Public; and which I shall describe and demonstrate, on the following Proposition.

PROP. VII. You are required to lay down sure, quick and cheap Methods, for the building of a most substantial temporary Bridge, with Stone Piers; the Arches (or the Spaces between the Piers) are to be made of Timber; the River at some spring Tides is ten Fathom deep, as was more fully described in the last Proposition.

METHOD laid down in **PLATE XXXIX.** Scale 12 Feet to 1 Inch.

Let us here suppose, that the Coffers are stuffed and floored over with cut Stone, as represented in Plate XXXVIII. Fig. 1. on which you are to be determined, whether you are to go on with the cut Stone Work to the springing Course, as Fig. 2. and also Fig. 2. in Plate XXXVII. or whether you are to begin the temporary Pier on the Floor or Platform of cut Stone; but I should advise you to the former, because it will be better, and there will be so much done for the next Generation; but in either of these Cases, observe, that

Plate

Plate XXXIX. is designed from the high Water mark of the last Proposition, and extends to half of the two middle Piers. Wherein note, e. Is the high Water mark, which is the same of e. in Plate XXXVI. and in both. f. Is the Surface of the Pavement. g. The lower, or principal Braces, which ought to be made of sound hearty upright Oak, of 18 by 12 Inch Scantling. And the King-post, h. may be the same; but all the rest of hearty and sound red Fir. i. The Collar-beam. k. Principal, l. and m. The two main Braces. n. and o. The principal Beams, which you see lie one upon the other (but it would be adviseable to lay Slips of sound Oak Plank between them, upon a slant, to turn off the Rain Water, and particularly the out-side ones, to keep them from rotting) These four, viz. l. m. n. and o. Are to have breaking Cuts run through them, and turned End for End, and then bolted together, provided that your Span is as great as this. The Prick-posts p. and q. are designed to shorten the bearing, and unite their Strength. All these, that is, i, k, l, m, n, o, p, q, are to be about a Foot square; and each of the Frames are to be placed about four Feet distant from each other, the outward ones are to be tried up, &c. The crown Beam r. is 18 by 12 Inches. The flooring Joists which lie on the Beam, o, are to be nine Inch Scantling, and spaced at 18 Inches asunder. On these Joists the flooring Planks are to lie, which are to be six Inches thick, this Floor may be first covered with Pitch and Tar, and then with common Slates, and one or two Courses of Bricks on them, laid in swimming Beds of choice Mortar, closely wrought and grouted. These Slates are to preserve and prevent the Mortar from corroding the Planks, and over the Bricks lies the Pavement of the Carriage-way, f. for which see Plate XIX. Fig. 3. and the Foot-ways may be the same as therein also delineated. These Slates, Bricks and Stones, if properly executed, will effectually throw off the wet, and help to preserve the Timber; but do not forget that I have mentioned different Methods for that Purpose, but they are to be applied at your own Discretion. And I think it would also be very advisable, to have this Bridge inclosed with a Stone Ballustrade, at least over all the Arches; but in this Case, there must be a pair of Frames placed together at the Extre-

Q 2

mities,

mities, to support the Parapets, which must rest on a heading Course of cut Stone, of about 4 Feet long each, and Chain-barred, &c. for if it is inclosed with Timber, it will be a perpetual Expence to keep it in order.

I need not be at the Trouble of enlarging on the Strength of these Timbers, as I presume, it is obvious enough, that they are sufficiently strong, to sustain the Weight of any Carriage whatsoever, perhaps, for a hundred Years without any Expence worth mentioning; but you are to observe, that the Pavement must have reasonable Time to cement, and that it is to be plentifully covered with Gravel, before any weighty Carriages are allowed to draw over it. As to the Expence of the Timber necessary herein, that I have not estimated, but I can venture to say, that I believe all this Timber and Workmanship, would not very much exceed the Expence of the Centers, Sheeting, &c. that would be necessary to turn such a Stone Arch upon. As to its Durableness, if there be proper Care taken to prepare and preserve the Timbers of the outside Frames in particular, which are to be exposed to the Weather, but especially at the Joints, u. w. and to throw the Water off from rotting the Buts of them that go into the Wall, I am confident that the rest of it, which has the benefit of the open air, and so effectually sheltered, must in the whole last at least as long, as Fir Timber can be expected to last in any other building.

Thus, you now see before you, the Method which I have so particularly recommended to the Consideration of the Gentlemen of those three Corporations, or of any other Community, that are in the like Situations; and all that I think now remains, is briefly to move one Consideration more with respect to Roads, which are necessarily connected with our Subject.

I have already observed, and the least Degree of common Sense will direct, all Persons concerned in projecting a Bridge in any Country Place, to look out for a Ford or some shallow Part of the River, because, it will probably, be both cheaper and the more expeditious. And that by pursuing these Methods, it is evident, you need not be under the least Anxiety with respect to the Depth of the Water, provided it be in Moderation. Therefore,

fore, before you fix on the Scite of the Bridge, (if that be left to you to determine) you are to procure correct Maps of the adjacent Country on both Sides of the River, view the Grounds yourself, and consider not only the Roads that are made, but also such Roads as must be made hereafter; and then summing all up together in your own Mind, you are justly and impartially to recommend the best Scite for the Bridge, that you are convinced will be most for the Advantage of the Public in general, without paying the least regard to any one particular Proprietor of the adjacent Lands, nor suffer yourself to be knowingly led into an Error, that may either injure your Character, or prove prejudicial to the Public, without fairly and fully extricating yourself from any Charge that may afterwards be brought against you, let the after Consequence be what it will.

If you should happen to be in any Ways concerned in Military or Naval Affairs, then these Methods may also in other Respects become of still greater Advantage, but especially in remote or desolate Countries.

His present Majesty has of late Years made great Acquisitions, and extended his Arms almost over the whole Globe. It is evident that these Methods may probably be attended by very salutary Consequences, to the Inhabitants of those Countries in general, where large Stone Bridges could not be accomplished in deep Rivers, for want of a sufficient Number of Workmen, and proper Materials for it. But further,

If a new Bridge happens to be built in any Country Place, the Public ought to be conducted to it, and that cannot be done without making new Roads; in the Execution thereof, various Difficulties may happen to be met with. There is no Doubt but it will be designed, that this new Road will be carried in direct Lines; perhaps, Part of a fresh Water Lake may Intervene; and frequently fresh Water Lakes, quaking Bogs, Morasses or the like, happen in the Way and obstruct laudable Designs, obliging the Undertakers to carry the Roads many Miles about, to the no small Disadvantage of the Public. Now let us endeavour to surmount these Obstructions, and consider what eligible Methods may be pursued,

in

in order to carry a Road in a right Line through such Places, not only to accommodate the Public, but as being productive of various other Advantages to private Property, in draining and reclaiming flooded or boggy Grounds, by intersecting the Current, and giving it a more advantageous Direction.

C H A P. XVI.

Concerning some Endeavours to apply Coffer-work to other private and public Purposes, on Land or in Fresh Water.

IT is not my Intention, neither is it possible for me to point out all the various Purposes, to which Coffer Work may be applied; but I shall now give an Instance, wherein I think both private and public Utility are greatly concerned, in order to excite your own Ingenuity to extend it.

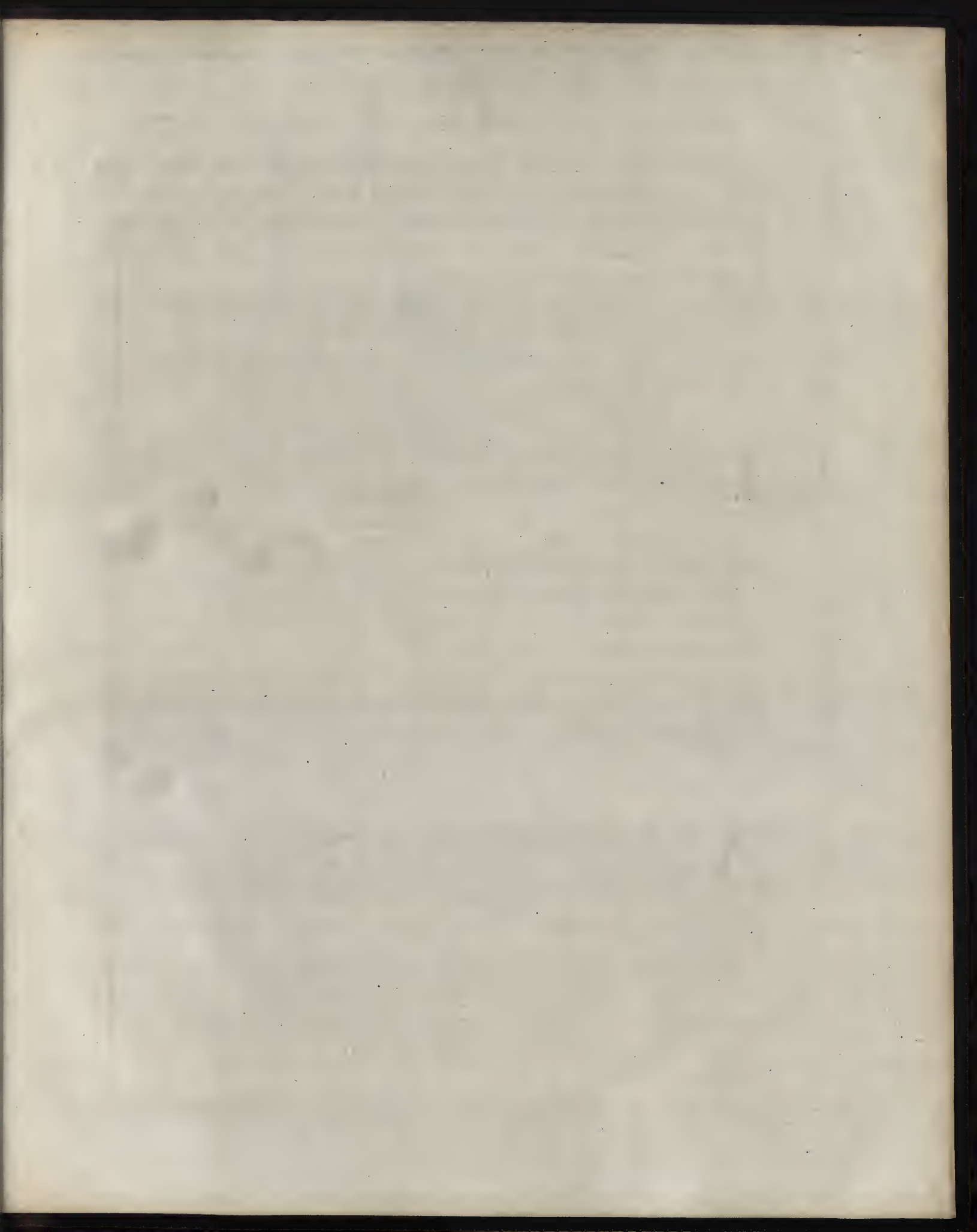
Our Country greatly abounds with deep mossy and marshy Grounds, numerous Loughs and fresh Water Lakes, to the great Loss and Detriment of the Proprietors and Public in general: Let us, therefore, try whether or no any of these Methods may prove useful either for the reclaiming of Ground, or shortening the Roads in populous Countries. As for instance.

S E C T. I.

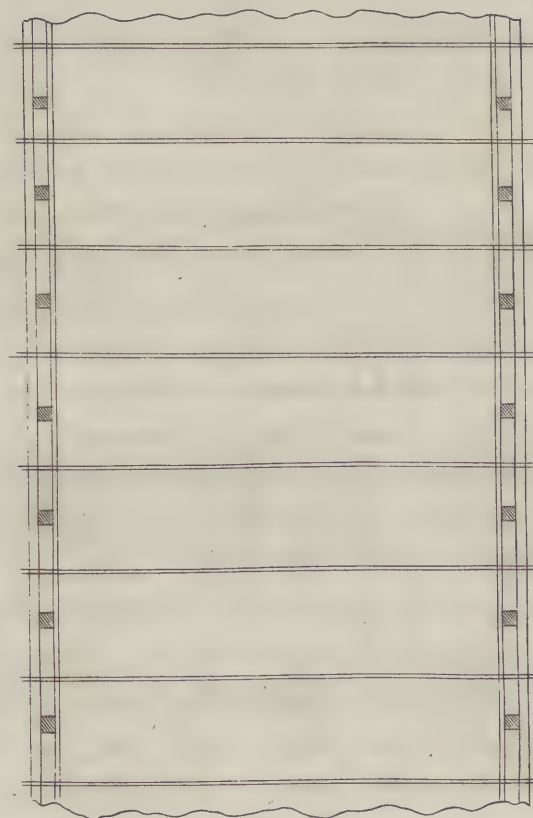
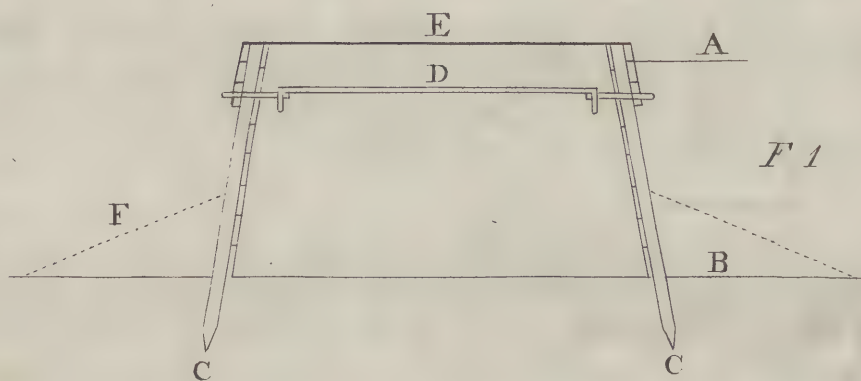
AGENTLEMAN's Country Seat lies contiguous to a spacious fresh Water Lake, which in Winter greatly overflows, and renders a large parcel of his Estate not only useless, but also entirely obstructs a short Communication from that Neighbourhood, to an adjacent Market Town. Therefore

PROP. VIII. *It is required to make a cheap temporary Road through part of a Lough, 9 Feet deep, on a Marley Bottom, that may also serve as a Mole or Bank to confine the Water from overflowing the Land; or in some Cases to dam it off, till a substantial Imbankation may be erected.*

METHOD



Pl. 40.



METHOD *laid down in* PLATE XL. *Scale 8 Feet to 1 Inch.*

Fig. 1. Represents the Section of the Mole, wherein note, A. is the Surface of the Winter Water, which is 9 Feet deep to B. The bottom of the Water. C. C. Two Rows of square Piles, to be sheeted on the inside with 1 $\frac{1}{2}$ Inch Plank, which must be ledged together, and floated in on Edge between the Piles and temporary Poles, to keep the Sheeting upright in its Place till the Stuffing is put in, and then the Poles are to be taken away. D. The Chain that Braces both Sides together, which need not be very strong as these Piles are battered. E. The Road or Surface of the Mole, and F. The Bank of any common filling.

Fig. 2. Is part of the Plan of the Mole with the Sheeting on the inside, and the double Ribbons on the outside of the Piles (like Fig. 2, Plate XXXIV.) with the Chains that are to strain them in, and keep them to their batter, which may either be very strong Plow Chains, or Inch square Bar Iron, &c.

You are to begin your Stuffing and Banking at the Shore, whence you are to be supplied with it, and to carry them both on together, and your Carts and Cars having sufficient Room, they are all to come in on the right Hand, and return to the left, to keep them from interfering; and whilst this is doing, your Carpenter is going on with another range on each Hand before them.

If this lies within View of the Gentleman's House, probably you will be required to enclose it with Chinese Rails; for which Purpose, you are to prepare your Posts as directed in Chap. XIV. Sect. 1. and drive them down by the Sides of the Heads of the Piles; but if it lies remote, you may drive down strong rough Stakes, and plat them with the Branches, for this is only a temporary Work, and there ought not to be much Money expended on it, because, if it conquers, and effectually keeps off the Water, the Gentleman, or the Public, or both, may be, perhaps, better accommodated with a substantial Road, or Imbankation. After you have fully considered the next Proposition, or by the Directions formerly given for Quay Walls, you may build a double Wall

on the reclaimed Side, at any convenient Distance, and this will perhaps, effectually keep the Water off from you in the mean Time; but let us also suppose, and lay down Methods for making a substantial Turnpike Road, through a shaking Bog, which may happen to intervene, and erect Forts or other weighty Building in the same.

S E C T. II.

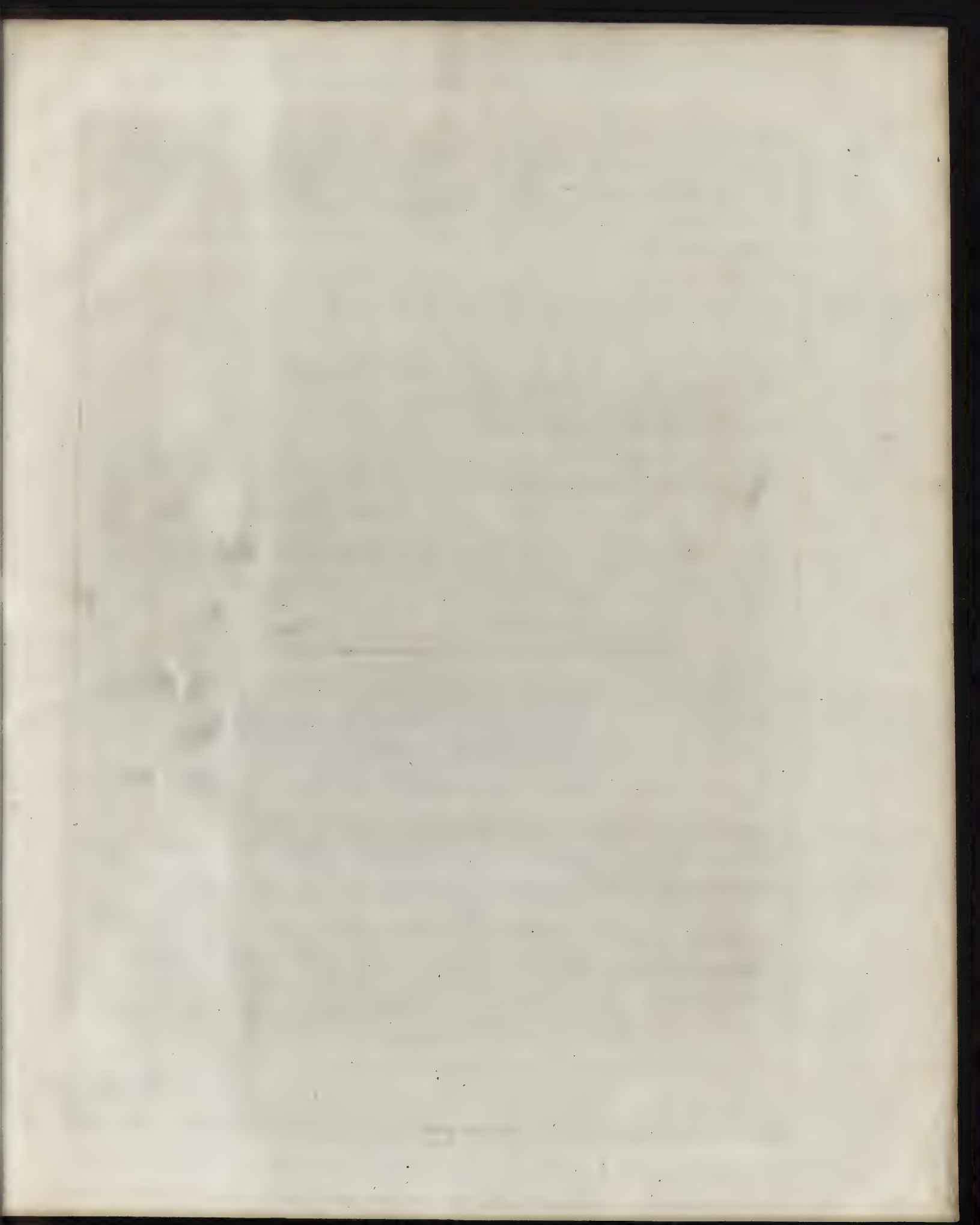
The Method of making a substantial Turnpike Road, through a quaking Bog of 15 Feet deep, and to erect Forts or other weighty Stone Buildings in the same.

WE are informed that many such Roads have been made by the antient Romans, some to the extent of several Miles in Length; but in our poor Country, we have no right to pretend to copy after them; but as Necessity is the Mother of Invention, let us try if we can contrive to form a Method of accomplishing a Work of this Nature, which is so absolutely necessary, not only for the reclaiming some of our Bogs, but also for the uniting the Neighbourhoods of two fertile Countries, that at present seem as remote from one another, as if they were in different Climates. As for Instance:

Between two very populous Countries, we will suppose, there lies a Valley of many Miles in Length, the greatest Part of which is liable to be covered with Water in the Winter; and even in the Summer, it is such a quaking Bog, as deters either Man or Beast from venturing upon it: The Public have therefore, taken it in Hand and resolved,

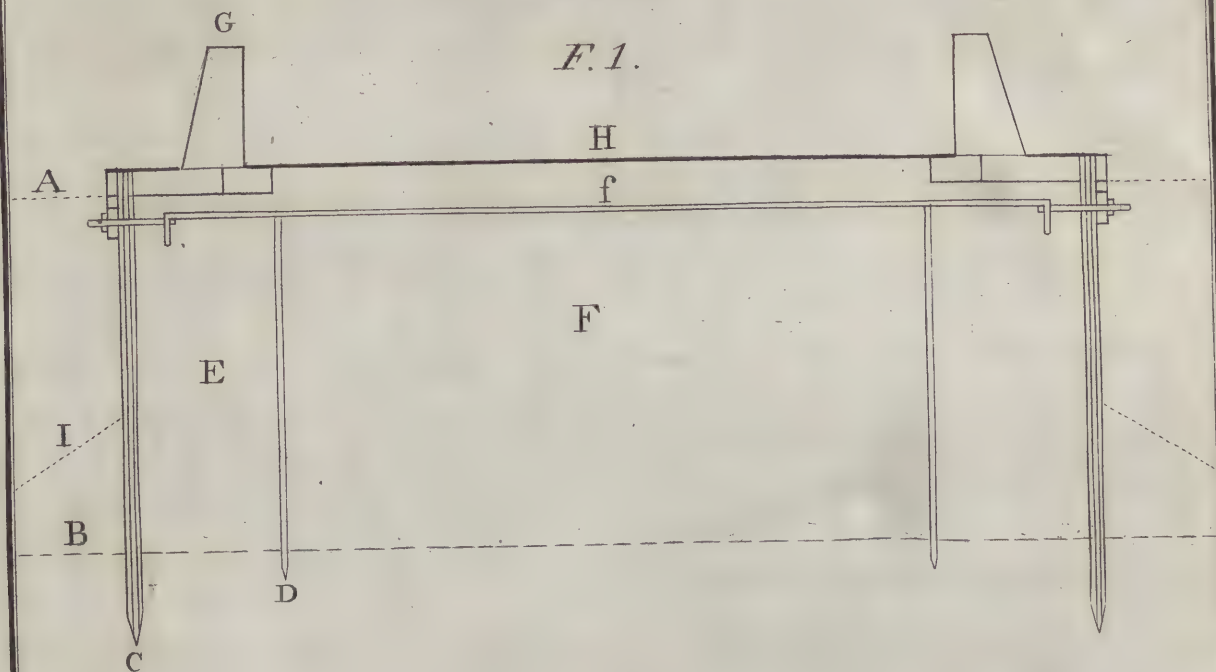
PROP. IX. *To make a substantial Turnpike Road, through a shaking Bog of 15 Feet deep, to be inclosed with parapet Walls of rough Stone and Lime, of five Feet high on each Side, and 30 Feet broad in the clear. In Summer Time, this Bog is generally covered over with a Scraw, or Scurff of mossy Grass, under which the Slutch is so exceeding soft, that a Stone of one Pound Weight will meet no Opposition, till it sinks to the Bottom, which is a stiff sandy Marl.*

Surely,

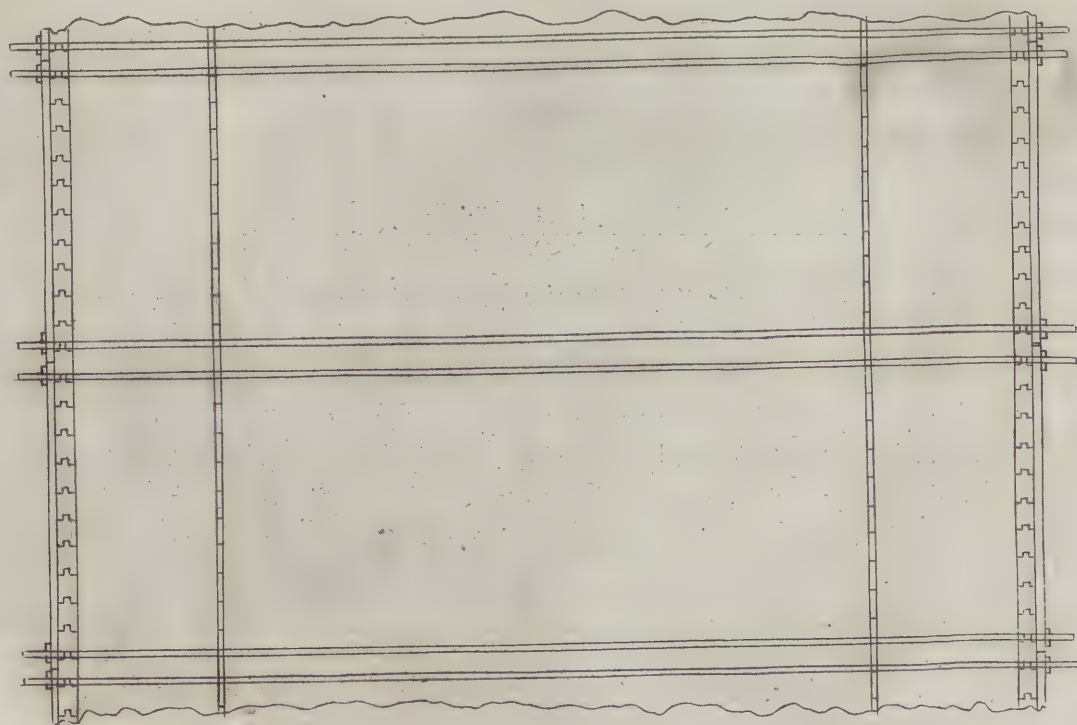


Pl. 41.

F. 1.



F. 2.



Surely, you must allow, that above all other Works, those that are done by the Public, ought to be performed after the most substantial and durable Methods: Let us therefore, now consider how this Work may be so accomplished. See

METHOD. PLATE XLI. *Scale 8 Feet to 1 Inch.*

Fig. 1. Exhibits the Section of the Road. Wherein note, A. Is the Surface of the Bog. B. The Bottom of it. C. The Dovetail Piles that form the Coffers. D. Temporary Piles or Planks that are to separate the Stuffing. E. The Coffers for the Walls; and F. the Coffers for the Road. E. is to be stuffed with small Stones, Lime and sharp clean Gravel, as before directed; but F. is to be stuffed or filled with the hardest gravelly and stony Stuff, you can conveniently get. Then the Planks D. are to be drawn up, as of no further use in that Place; because the Stuff that is to make the Road, would not by any Means be sufficient for the Foundations of the Parapets. And you see the stuffing E. is to be covered over with cut Stones of 4 by 2 Feet, and a Foot thick; and hence you see the Parapets are battered to 18 Inches thick. The stuffing of both E. and F. will settle considerably, but they will settle perpendicularly, and drive and disperse the Slutch of the Bog before them; and according as you find them settle, you must still continue to fill them up from Time to Time, as Occasion may require. f The Chain that braces them all together. G. Parapet Wall. H. Surface of the Road, which you see is here supposed to be but one Foot above the Surface of the Bog. I. Is the Banks which are to be raised at Discretion according as you go on, to help to Buttress and Brace in the Piles that form the Coffers.

Fig. 2. Is Part of the Plans of the Coffers, with the Situation of the Braces. In which observe, that the Braces are placed together in Pairs, which may have about ten Piles between each Pair, as before directed in Plate XXXIV. Fig. 2.

I do not pretend to say, that this Method is entirely of my own Invention, but to my Success in consulting several antient Histories, wherein I found sufficient Matter, together with what

I have before mentioned, for my grounding this Contrivance, not only for the present, but also the following Proposition upon: And notwithstanding I take great Pains to be concise, yet, I shall refer you to one particular Place, which you will find abridged in *Chambers's Dictionary*, under the Article of ROAD, which I before mentioned, and as that Book may not be in your Hands, I shall here transcribe exactly what he says.

“ Road, an open Way or Passage, forming a commodious
“ Communication between one Place and another.

“ The *Romans* of all People took the most Pains in their Roads.
“ The Labour and Expence they were at, to render them spacious,
“ streight and smooth, are incredible.--- Usually they strengthened
“ the Ground by ramming it, laying it with Flints, Pebbles, or
“ Sand; sometimes by a lining of Masonry, Rubbish, Bricks,
“ Potsherds, &c. bound together with Mortar.

“ *F. Menestrier* observes, that in some Places in the *Lyonnois*, he
“ has found huge Clusters of Flints cemented with Lime, reach-
“ ing ten or twelve Feet deep, and making a Mass as hard and as
“ compact as Marble itself, and which, after resisting the Injuries
“ of Time for 1600 Years, is still scarce penetrable by all the
“ Force of Hammers, Mattocks, &c. and yet the Flints it con-
“ sists of, are not bigger than Eggs.”--- Please to observe, that
this corroborates with the former Accounts given of the petrifying
Qualities of these Materials.

I do not say that this Road of ours, will be as firm and as substantial as these *Roman Roads*, because we only purpose to stuff the Coffers on which the parapet Walls are to stand, with those choice Materials; but I affirm, that if we were able to go to the Expence of such a Work, and this Bog was 20 or 30 Feet deep, it is practicable to make a Road through it as firm and as compact as theirs; because I am sure our Country abounds with as good Materials for that Purpose, as perhaps, any other produces, except the principal Material, *Money*, to carry on such a Work.

But notwithstanding our great Scarcity of this principal Material in all Works, yet Matters, perhaps, might be so managed, as to carry on a useful Work of this sort at a very moderate Expence;
and

and here we have a fair Opportunity to introduce one of the Methods I pointed out, in the latter End of the second Section of the last Chapter, which I advise you to recall to your Mind, and I shall now enlarge a little further upon it.

If such a Road is to be made through such a shaking Bog, you are to make such Coffers as is therein before directed, and exhibited in Plate XXXI. and throwing out the Slutch, &c. build a slender Pier in each of them of rough Stone, for about a couple of Feet above the Surface, and thereon to turn slight rough Stone, or hard Brick Arches, agreeable to the extent of your Design; and as you go on, draw up the Piles and apply them to the next Piers in like Manner, as also therein before mentioned; and to facilitate the Work, you may have several sets of such Piles. If Stones are scarce and Timber plenty, you may make a substantial temporary Causey over the Piers, but by all Means I would prefer the Arches.

It is well confirmed that numerous such Causeys, have been made through Morasses by the Antients, and that some of them have extended to eight Miles in Length, and thirty Yards in Breadth.

Numerous Forts and other sumptuous Edifices, have likewise been erected by them in Morasses; but the Conciseness of this Work, will not admit of my transcribing Abstracts from them. Let it therefore suffice, that I here briefly point out one of the Methods which I firmly believe must have been the Method practised by some of them. And I also conclude may most readily be executed at a very moderate Expence by us also. As for instance:

Let us suppose, that you are required to prescribe quick and cheap Methods for building a substantial Foundation for a Fort, or any other weighty Building of Stone and Lime of 200 Feet square, or any other large Extent, in a Morass or quaking Bog of 15 Feet deep, on a penetrable Clay or loamy Bottom.

Having thoroughly examined the intended Scite, and prepared Plans and Materials for the Purpose, by this *Method* (so fully explained above) you are to erect a competent Number of Pillars of strong rough Masonry, suppose of eight or ten Feet square, and perhaps eight, ten or fifteen Feet Distance from each other, and thereon turn segment Vaults and Arches, which will give you a

Platform, whereon you are to erect the intended Building, always paying due regard to the Pillars throughout the Superstructure. This Method is so easily understood, that I need neither form any Designs, nor enlarge any further on it.

But I shall give you another Instance, in which this sort of Coffer Work may also in many Cases be successfully applied, and have also been probably made use of by the Antients, in making inland Navigations through their Morasses.

S E C T. III.

Coffer Work applied to the making of a navigable Canal, through a Shaking Bog 15 Feet deep.

THE Valley before-mentioned, extending on almost a dead level, for great Part of the Space between two navigable Rivers, with several opulent Market-towns adjacent; we will suppose, that the Public have also taken in Hand, to turn the same to a national Advantage, and resolved,

PROP. 10. *To make a navigable Canal as a Communication between those Rivers, through the most convenient Parts of the Valley. You are, therefore, required to lay down sure, quick and cheap Methods to carry such a Canal through Part of a Shaking Bog, fifteen Feet deep, as before. See*

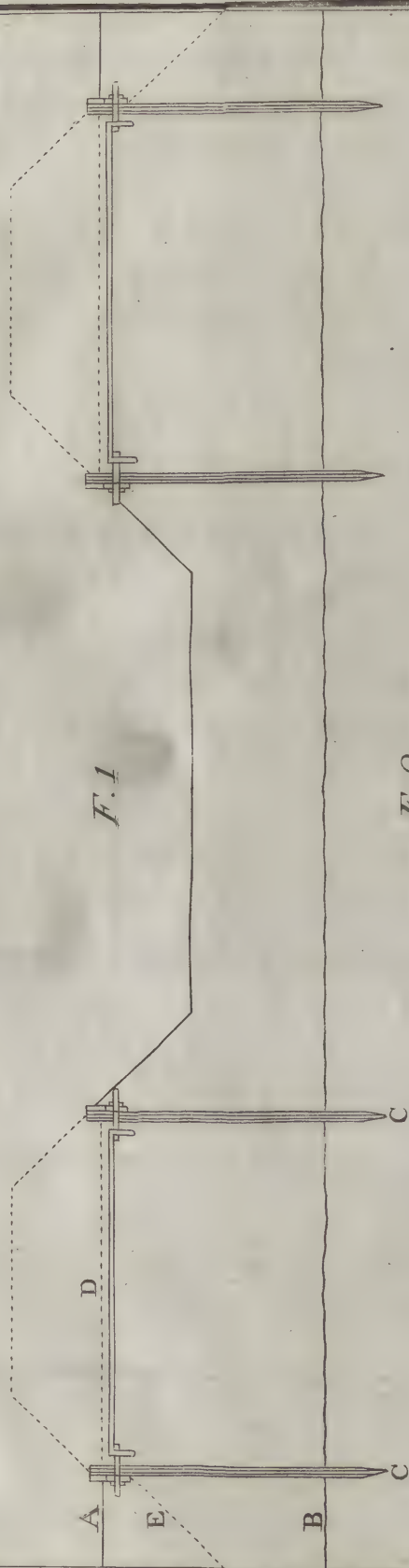
M E T H O D. PLATE XLII. Scale 12 Feet to 1 Inch.

Fig. 1. Represents a Section of the Canal. Wherein note, A. Surface of the Bog. B. Bottom of the same. C. Dovetailed Piles that form the Coffers, after the Manner of Figure 2, 3 and 4, in Plate XXXI. D. Brace-bars, Chains, or Scantling, and E. Bank, which is to be raised at Discretion.

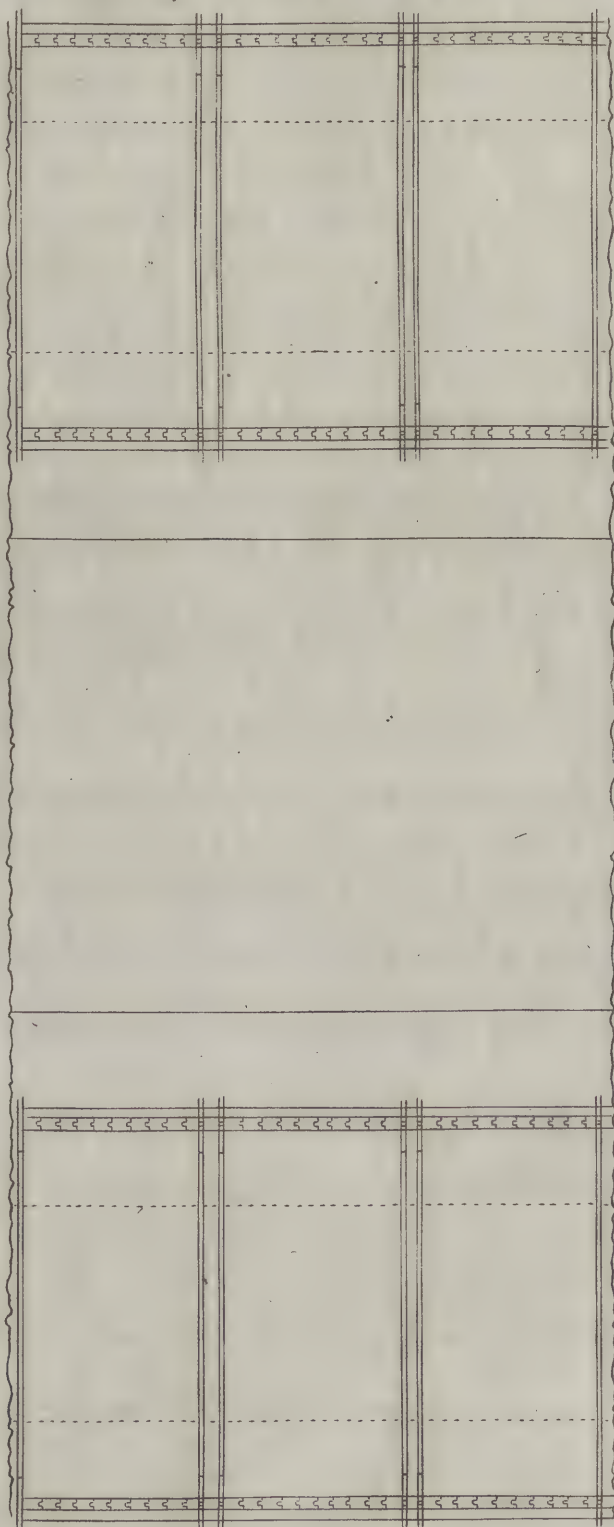
Fig. 2. Represents the Plan of the same, shewing the four Rows of Piles, Chains, Ribbons, &c.

These last two Propositions, if properly attended to, may also be productive of sure and effectual Methods of reclaiming extensive Bogs,

F. 1



F. 2



Bogs, and these Methods may be effectually applied to 20 or 30 Feet deep if necessary, and are so easily understood, that I need not enlarge upon them.

But before I conclude fresh Water-works, I think it adviseable to point out one Advantage, that may accrue in the Way of Trade and Commerce, particularly to such Merchants as traffic in foreign, unimproved Countries; that is, to make either temporary or durable Quays, or to run out Tongues or double Quays, into such Rivers as belong to their Settlements, and that at a trifling Expence. For which Purpose, observe, that if the Bed of the River be hard or rough, you are to design the Coffers pursuant to such Methods, as are deducible from Plates, XXVIII. XXIX. XXX. XXXV. XXXVI. XXXVII. but if soft and loamy, then you may pursue such Methods as may be collected from Plates XXXI. XXXIII. XL. or XLI. and from the explanatory Notes thereunto respectively belonging, together with what you will hereafter find described; always observing, to proportion the Coffers to the requisite Depth of Water, and in durable Work, on these Coffers you are to begin the Quay Walls as formerly directed; provided, Stone and Lime can be conveniently obtained; but if such cannot be procured and that Timber abounds, you may make temporary Quays, of such Heights as you think may answer your Purpose: And observe also, that by these Methods, you are to make Quays for launching your Coffers, &c.

In still Lakes or smooth running Water, you may easily contrive by these Methods, to run out temporary Tongues or double Quays with Timber, to such Height and Lengths, as to afford likewise a Harbour for small Vessels; but by no Means attempt it in any Place that is liable to be greatly agitated, except you have cut Stone from near the Surface of low Water; but I need not enlarge on these Matters in this Place, as I intend in the following Sheets to treat largely on such Harbours, as will be abundantly sufficient to withstand the Violence of the most turbulent agitated Sea. On which Subject, we shall first begin by laying down Methods to build a Beacon in shallow Water.

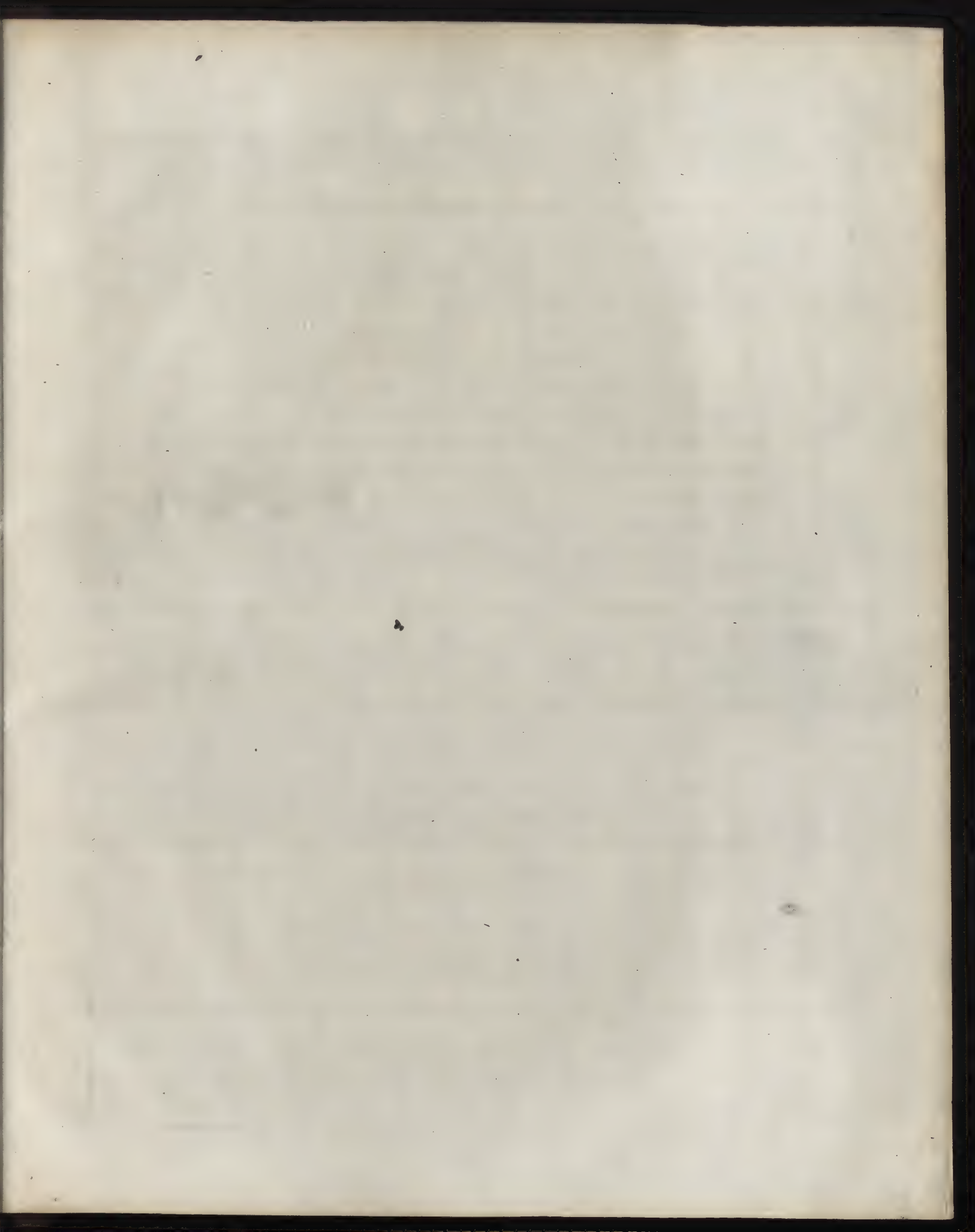
C H A P. XVII.

Coffer-work applied to Buildings, that may be thereby effectually executed in the Sea.

I HAVE had very little Acquaintance with Marine Affairs of any kind; and therefore, I presume, I may hope to meet with somewhat of Indulgence in my treating on Things of this Nature, and also for your own friendly Endeavours to assist me, in hopes of bringing these important Matters to some Maturity; as I have already insinuated, that there are but few Arts or Sciences, that have been brought to Perfection, by the utmost Endeavours of the first Contrivers of them.

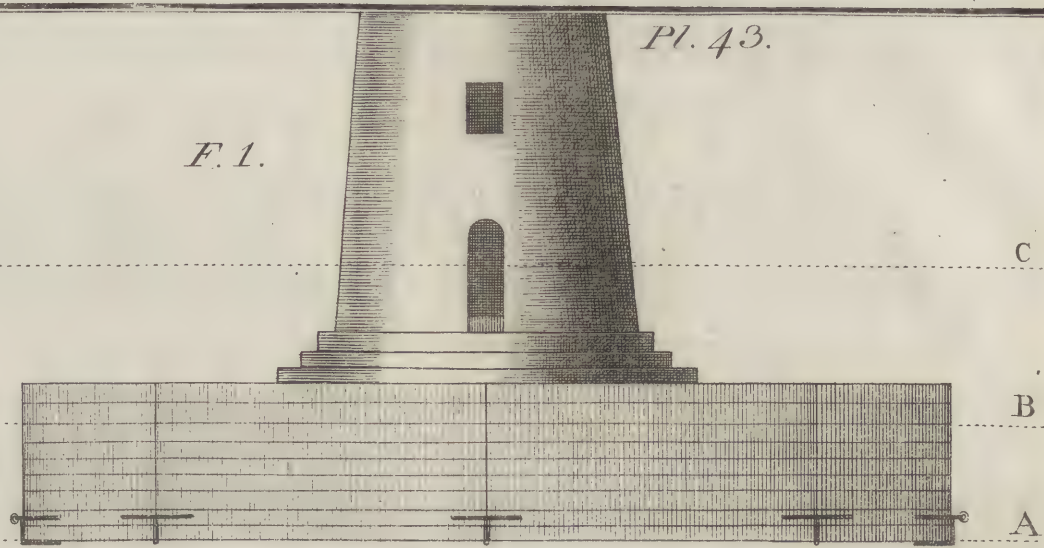
It is now upwards of 23 Years, since I first observed the Petrifactions mentioned in Chap. VI. Sect. 2. and from that Time to this, I have applied my feeble and utmost Abilities, in endeavouring to turn and improve my Observations to the real Advantage of the Public in general; and I think, it would be inexcusable to smother or conceal the Notions that occurred thereupon. But I entreat a patient Attention to what I am now about to mention, and I hope that my Plans and Designs will not be condemned as impracticable, until the real Merit of them are thoroughly weighed and considered; though I must confess, that if ever you have seen the Sea in a violent Storm, as I have several Times observed with a trembling Heart, I ought not to wonder at your entertaining some Doubts of Success, but at the same Time do not forget, that the Sea is not at all Times so violently agitated; and therefore, let us endeavour to contrive such sure Methods as may reasonably promise Success, and be accomplished with great Expedition, at any Time when a favourable Opportunity offers; for it is not the Sea alone that you have to encounter with, but the most astonishing and dreadful Effects of the Tides and Winds.

As to the ebbing and flowing of the Tide, we are most comfortably circumstanced; for, generally speaking, we can tell to wonderful

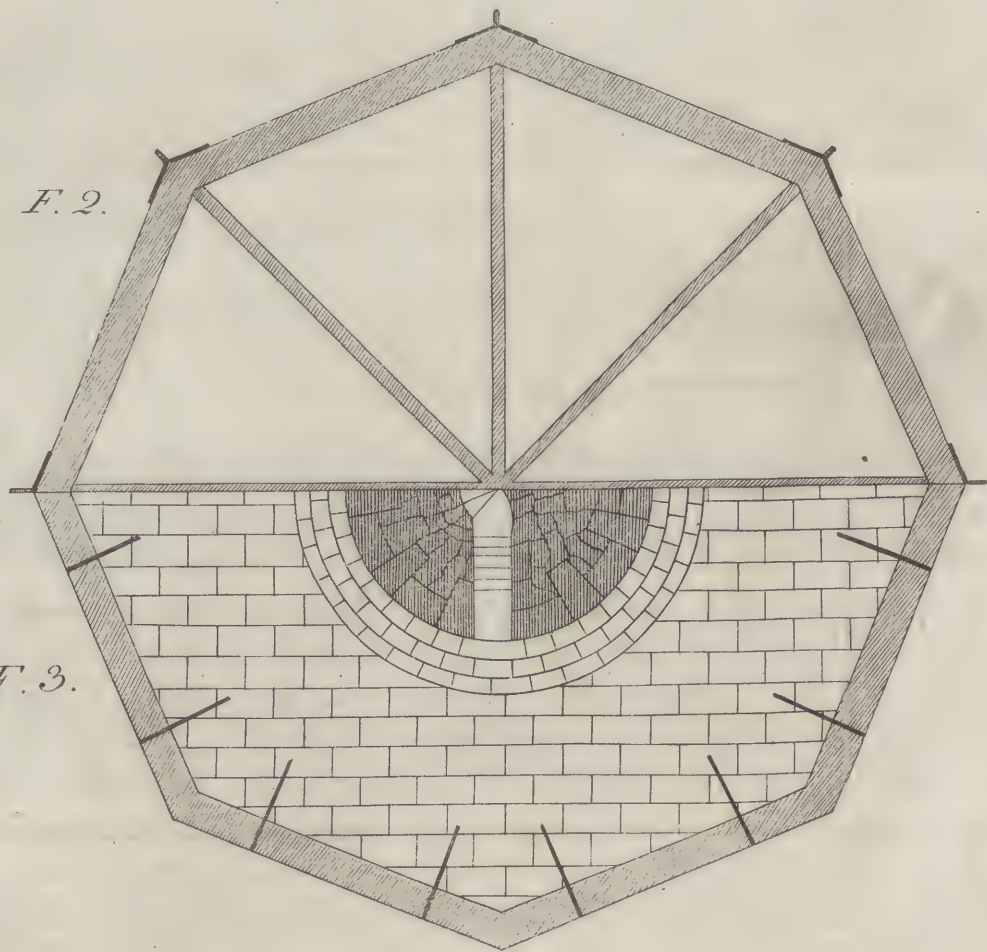


Pl. 43.

F. 1.



F. 2.



F. 3.

ful exactness, when it will flow, and when it will ebb; when we may expect high Tides, and when we may hope to have low ones. But I believe no Man has been able to tell precisely the Height that some spring Tides may rise to, nor the Height and Power of the Winds when united with them. In this Case, therefore, you must paint to your Imagination, the most powerful Effects of them you can possibly conceive, and design your Work after such firm and substantial Methods, that it may be able to withstand their utmost united force: And in order to exert our best and utmost Endeavours, let us begin with a small Beacon, or Light-house, before we attempt the more weighty Matters intended.

S E C T. I.

Concerning the building of a Beacon, or Light House in the Sea.

PROP. XI. **T**O build a substantial Stone and Lime Beacon, or Light House of 20 Feet Diameter in the Sea, the dead low Water being about eight Feet deep; and spring Tides sometimes rise ten Feet more.

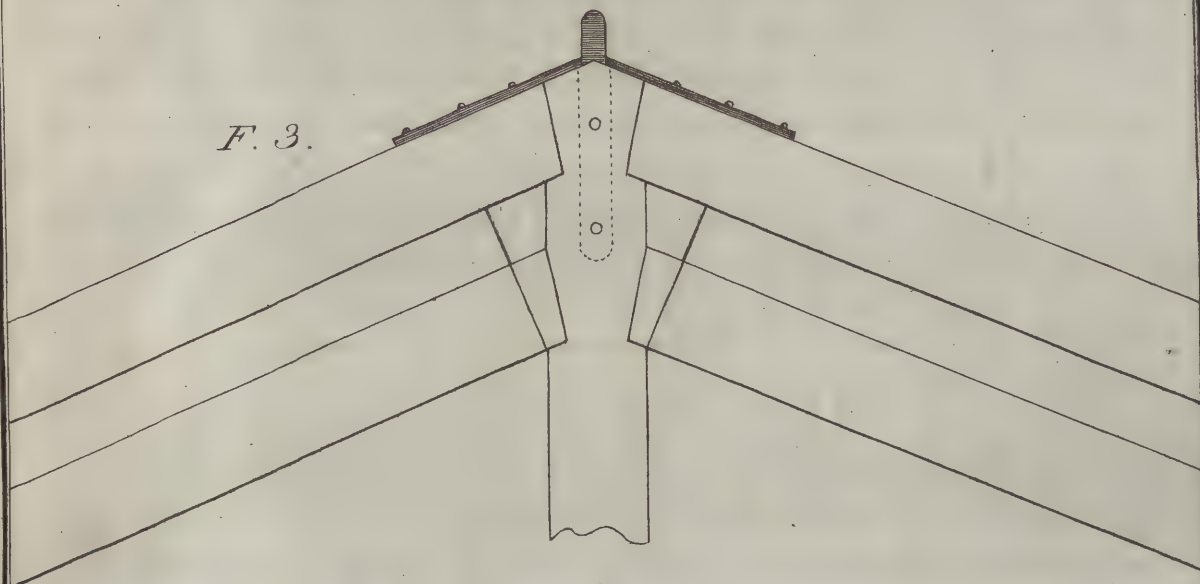
METHODS laid down in PLATES XLIII. XLIV. XLV. and XLVI. Scale 12 Feet to 1 Inch.

Plate XLIII. Fig. 1. Furnishes you with an Idea of the Land-front of the lower Part of the Light-house, standing, as it were, upon the Coffer, stuffed and floored as formerly directed. Wherein note, A. Bottom of the Water. B. Low-water mark. C. High-water mark. Fig. 2. Shews the Ground-plan of the principal Timber of one half of the Coffer, exclusive of the Grating. Fig. 3. Represents the Surface of the other half of the Coffer, floored with the Cut-stones, and cramped as before directed; and also, the Plan of the lower half of the Light-house, which is to be wrought solid with cut and large scabbeled Stones, except the Stair-case.

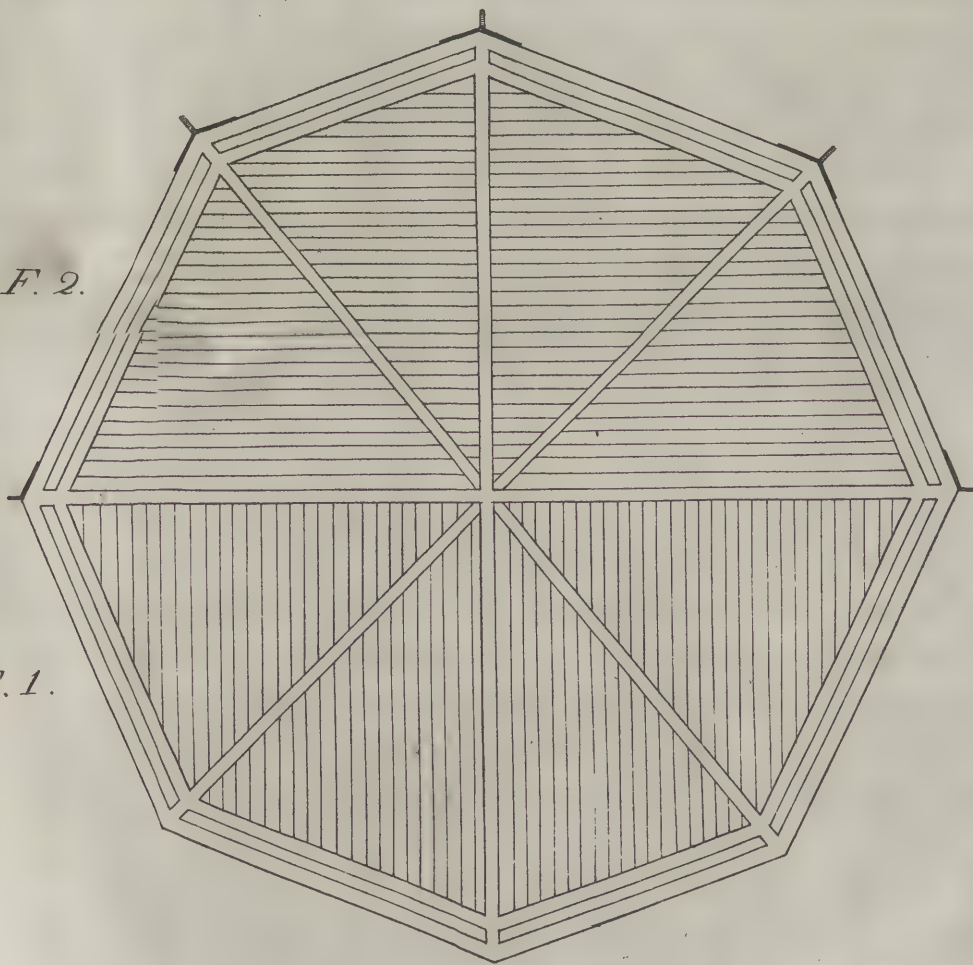
Plate XLIV. Fig. 1 and 2, (Scale 12 Feet to 1 Inch.) Shews the principal Timber and the Grating. In which observe, that all the principal

principal Timbers are to lie exactly over one another, and so are all the extreme Timbers that furround them. Fig. 1. Represents half of the 1st Course, and Fig. 2. half of the 2d Course, which together make the Grating or Bottom two Feet thick, in both of which, the principal, or diagonal Beams, are to extend 60 Feet 8 Inches; four Inches being allowed for the set-off, that is to be on the 2d Course: And as you cannot get Timber of 60 Feet long, you are to take particular care that the Timber of the 2d Course, shall break Joints with the Timber of the 1st Course, and that they be both firmly spliced and bolted together, to prevent their wrecking, swagging or dislocating by any Accident or Mismanagement in the launching of the Coffer. And besides these Iron Bolts, there must be an Abundance of Oak Keys, both through the principal and through all the outward Timbers. By Oak Keys, I mean, that you should get a competent Number of Pieces of Oak tried up, of about 2 Feet long, 9 Inches broad and 4 thick, each. The Mortices for them, must be made quite through each Piece, and exactly answerable to each other; and these Keys must be drove into the Mortices, and pinned with Oak Trundles of about full Inch Diameter, so as both the under and upper Courses of all these principal and outward Timbers, may be firmly united together. And you see that between these outward Timbers in each Course, there is to be a Vacancy of eight Inches, and in this Vacancy the upright Piles are to stand, which Vacancy, and the Manner of framing the diagonal and outward Timbers together, you may see laid down in Fig. 3. (*Scale 2 Feet to 1 Inch*) and when these two Courses are compleatly united together, you are then to put on your angular Plates on the upper Course, and in Case you have no Sea-braces, then each of these Plates are to have three Wings, two of them are to encompass the Angle, and the third is to go underneath the End of the diagonal Piece, with two Bolts through each of those Pieces, as you see marked out in dotted Lines. The Neck that proceeds from these three Wings must be of about the Substance of full three Inch square Iron at the least, with either a Hole, or a Ring, to receive the buoy Ropes, as has been formerly directed; and

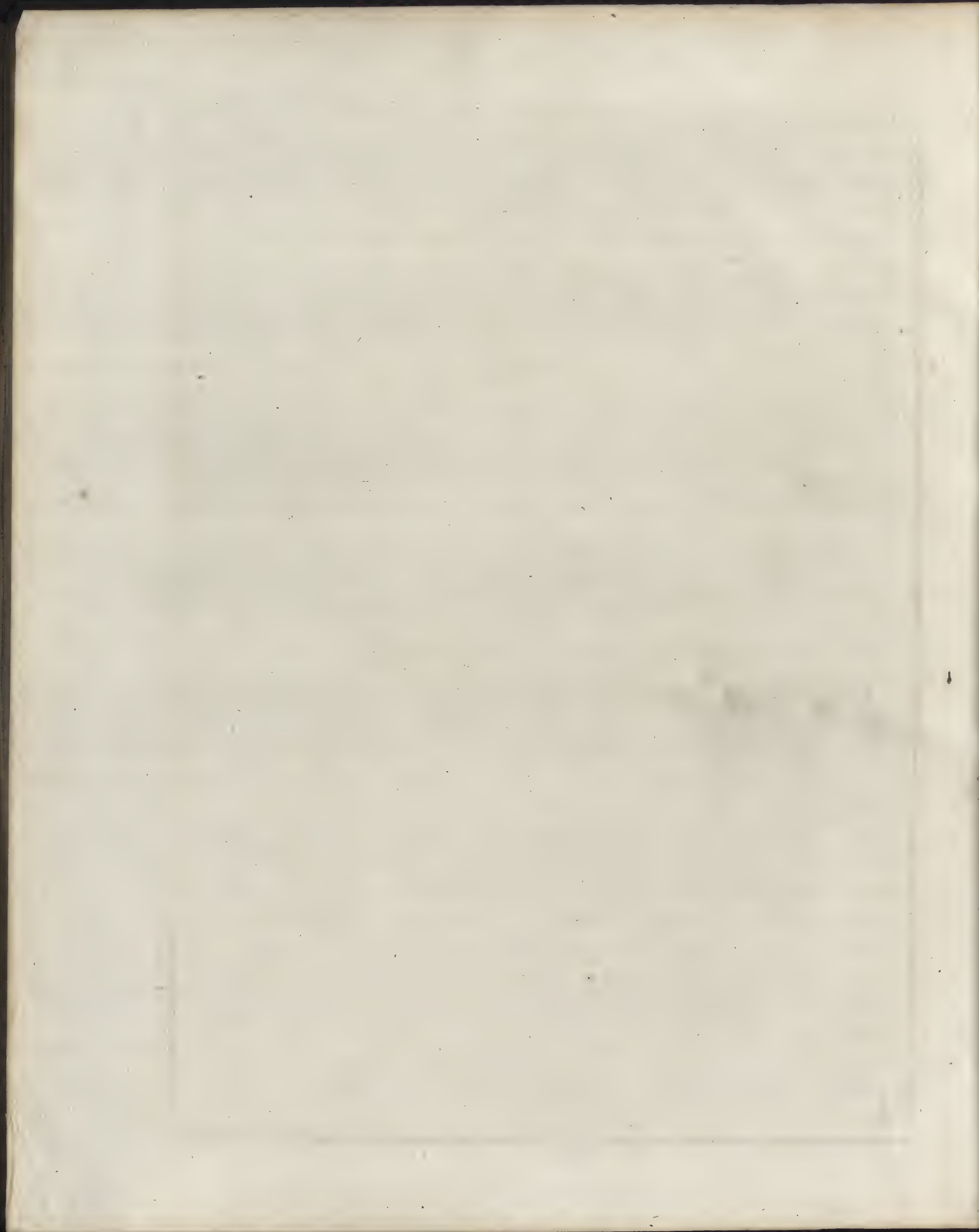
F. 3.



F. 2.



F. 1.



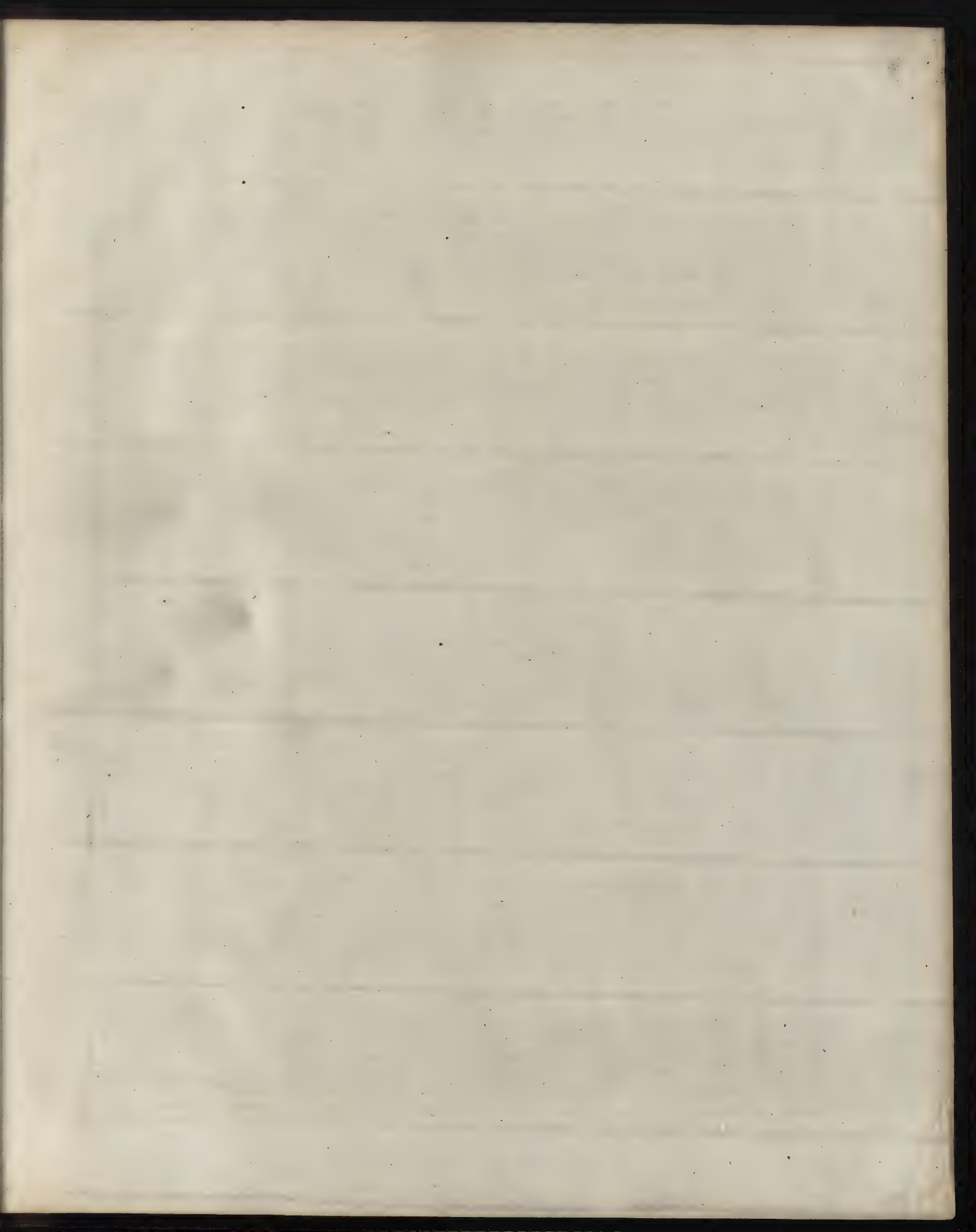
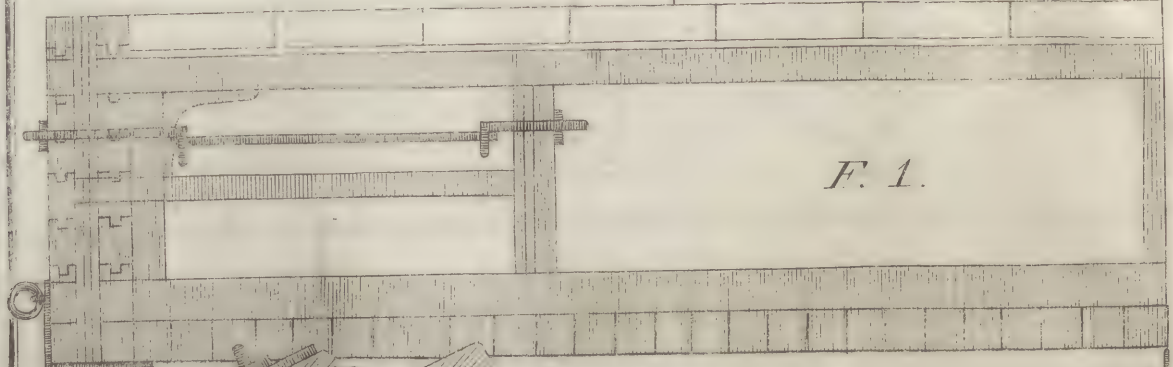
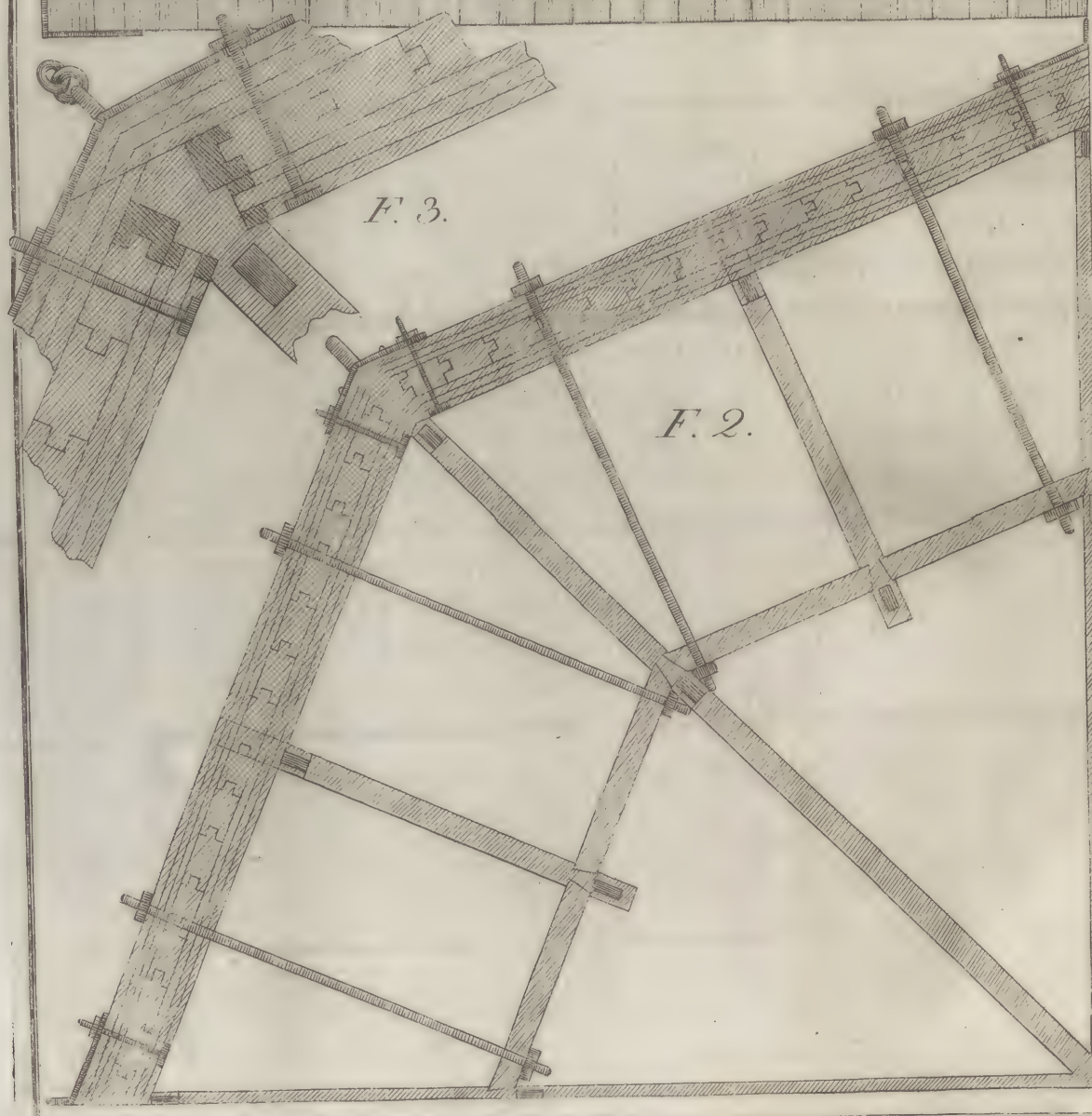


PLATE.



F. 1.



F. 3.

F. 2.

and if you have Sea-braces, you will find them described in their proper Place.

Plate XLV. Fig. 1. *Scale 5 Feet to 1 Inch.* Is the Section of one quarter of the Coffin, as if it was compleatly stuffed, with the cut Stone Floor, and the four first Courses of the Light-house built upon it. Fig. 2. (same Scale) is the Plan of the upper Timbers of that Quarter, with the Brace-bars and other Iron Work. Fig. 3. *Scale 2 Feet to 1 Inch.* Shews you how the three Rows of Piles are united together. You see that the Hull is composed of three Piles or Planks of eight Inches thick each, and their Breadth at Discretion. They are all to be tongued and grooved as formerly directed, and firmly pinned and bolted; the three Piles taken together, making, as it were, one solid Thickness, of which the middle Row (as you may see by the Section of the Hull, Fig. 1.) is the Tennon, and goes down two Feet between the outward Timbers, which are the Base of the Hull; through each of which outward and inward Pieces, and through each of the upright Piles, there are to be Oak Trundles drove, of an Inch and a half Diameter. In this Fig. 3. you also see the corner Posts, into which the diagonal Pieces are to be double dovetailed; and also, the Tongues of the two next upright Piles are to be let into Grooves, which you are to prepare for them therein, and so are the Ends or Tennonns of the inside horizontal Piles also. These corner Posts are to be made of Oak, in two Parts, which are to be firmly keyed and bolted together, after you have made all the Grooves and Dovetails belonging to them; and you must recollect the Vacancy left between the out-side Timbers in the last Plate, and make two Tennonns in the Foot of this Oak Post, or double Post, exactly to fit and stand in the Vacancies, one on each Side, to fit the dovetail of the diagonal Beam, in which two Places they are to stand, as it were, on two Legs astride the diagonal Beam, wherein they are to be securely bolted. And I must repeat, you are not to forget, that in the Middle of the Intersection of all the upright and level Piles in the Hull, there are to be Inch and half Oak Trundles drove tight through them, and wedged in the inside. Every Pile of the outside is to be dovetailed at the Angles, like so many Belts,

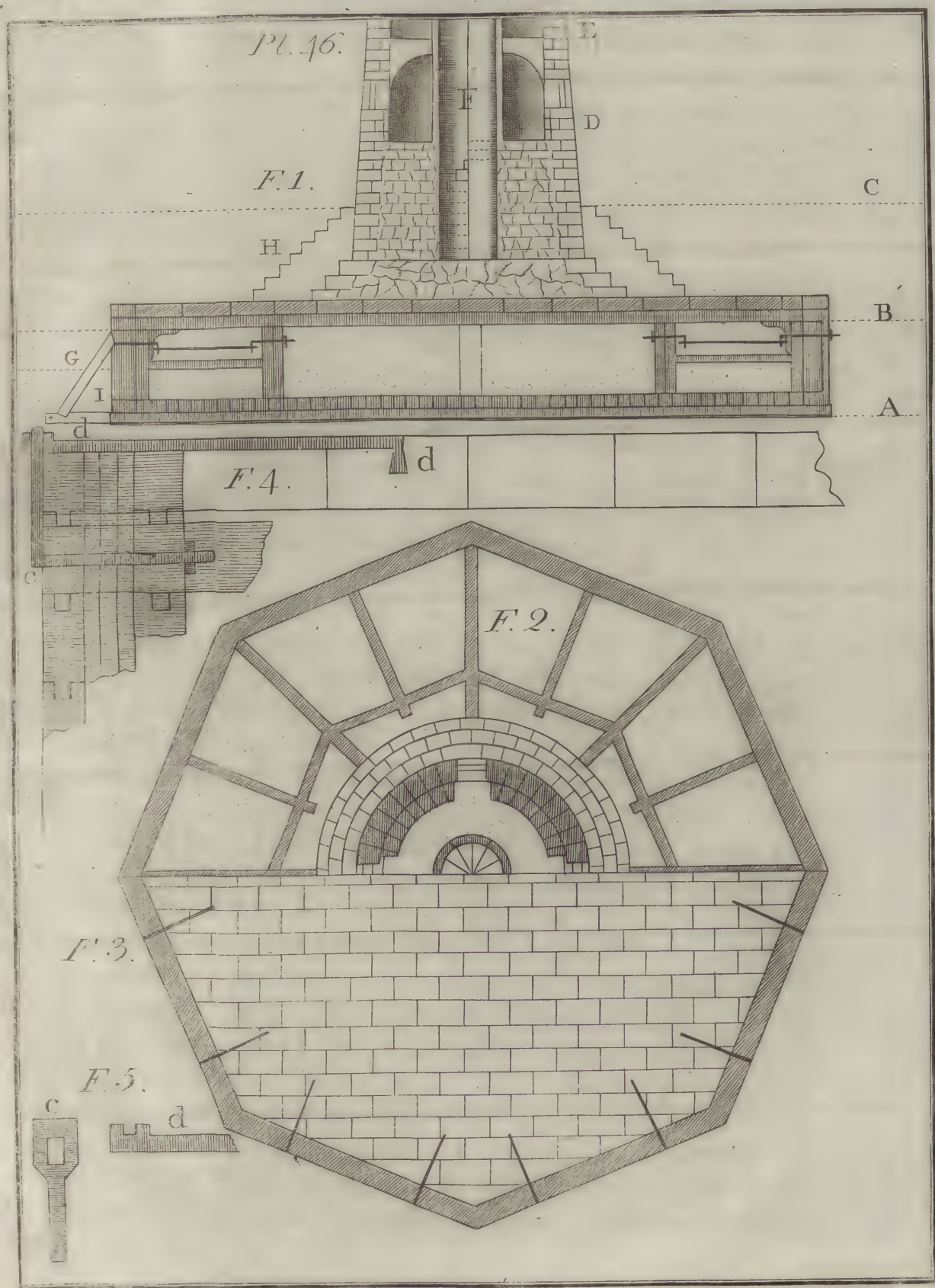
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to confine the whole Hull together, and you see how the Iron work is to be applied thereto; but you must also strictly observe, that all the Tongues and Grooves, both in the upright and level Piles, are to be done after a Workman-like Manner, so that the finest Particle of the Sand, or even the Lime-water, may not be sucked out through them by the Waves. Indeed the Joints in the Bottom may be an Inch wide, because when it is launched, it will let the Water into it, which will help to sink it, and the finer Particles of the stuffing will soon fill them all up, of which you must here allow an extraordinary Proportion, and the Bank will secure them all.

Plate XLVI. Fig. 1. *Scale 12 Feet 1 Inch.* Represents the Section of the whole Coffer, as if it were stuffed and floored with Cut-stones; and the Section of the lower Part of the Light-house, as if it were standing upon it. Wherein note, A. The Bottom of the Water. B. Low-water mark. C. High-water. D. The first Floor of the Light-house. E. Part of the second Floor. F. Well-hole of the Stairs; and G. The Bank to be raised at Discretion; but strictly observing not to let any Stone exceed a Handful in your banking: Because, a large Stone is to the Waves, as a large Tree is to the Wind, which will give great Opposition to it, when at the same Time it will pass gently over diminutive Shrubs; which is evident by the Breakers on the Strand. Besides, large Stones make large Cavities, and large Cavities contain large Quantities of Water, and large Quantities of Water operate much more powerfully than small ones, which I shall demonstrate hereafter.

Fig. 2. (by the same Scale) Shews you the Plan of the upper Timbers of the Coffer, the Plan of the Stairs, and the first Floor of the Light-house, with the circular Bar that is to be let into that Course. Fig. 3. Represents the Platform or Surface of one half of the Coffer, stuffed and floored with the Cut-stone; and the eight strong Lines represent the Cramps, which must be made of $1\frac{1}{2}$ Inch square Bar, and sunk something more than their full Depth into the Stones, so that the melted Lead will entirely cover them, and when they are eaten with rust, they are easily replaced, or more added if necessary. Fig. 4. (*Scale 2 Feet 1 Inch.*) Shews you the Method





Method of cramping the Hull and the Cut-stone together, *viz.* The square c. goes through the three Piles or eight Inch Planks, with a Screw-nut on the inside. The upright of c. has a square Hole in the upper End of it; and the End of the Cramp, d. is to take hold of that Hole, which you are to thrust into it after you have cut or sunk the Channel across the Heads of the Piles, or Hull, and the cut Stone, which you may more clearly perceive by Fig. 5. (*Scale 2 Feet to 1 Inch*) Wherein note, that c. shews the Hole, and d. the End of the Cramp that goes into it; but if it should happen, that such a Building was to be erected in any Place greatly exposed to stormy Flood-tides, especially off the Atlantic Ocean, I particularly advise, that you may add eight projecting Steps in like Manner, and in the stead of those three; and then the naked Body of the Light-house will stand on the Summit of the eight Steps, which are just at the High-water mark, which will put the Light-house quite out of the Power of the Waves, as you see it marked out at H. And you may also extend the five principal, or diagonal Sills (in Plate XLIII. Fig. 2.) six Feet toward the Sea, and thereon fix your five Sea-braces, as in Plate XLVI. Fig. 1. Letter I. and on the Ends thereof, you may securely fix the five hauling Rings, at the End of each of the five Sills.

In Case you are required to erect a more substantial Light-house, suppose of 40 Feet Diameter, the Coffers must at least extend 120 Feet, and be made in two or four separate Parts, just as the Timber, and other Circumstances, may best answer your Design; but in this Case, you may set it upon eight Steps as above mentioned, each of which is an Arch in itself, and $\frac{3}{4}$ of the Length of each Stone will be tied in covered and secured with the next Course that is over it, and so the Waves will not have any Power to disturb them in the least Degree.

And in Case you should think it necessary to secure the Coffer or Coffers more effectually, you may environ and secure them with double or single Guard-coffers; but if you do them in that Manner, you are to omit the Sea-braces of the inner Coffers, that they may be sunk as close to each other as possibly you can; and let the Sea-braces be fixed to the Guard-coffers, as before directed, in Fig. 1.

Letter I. Observe also, that in stuffing the Coffers in the Sea, you must be much more liberal in the Proportion of Lime, than what we concluded upon for fresh Water-works, because it will be in much more danger of being both wasted and weakened; therefore, if you can procure Lime at a moderate Price, bestow it bountifully on such Work as these; for it is the Lime alone, that creates the Petrification, and by all Means, that ought to be promoted. And if I have been too penurious in proportioning that expensive Article, let your own Discretion, tempered with a little experimental Knowledge, conduct you therein.

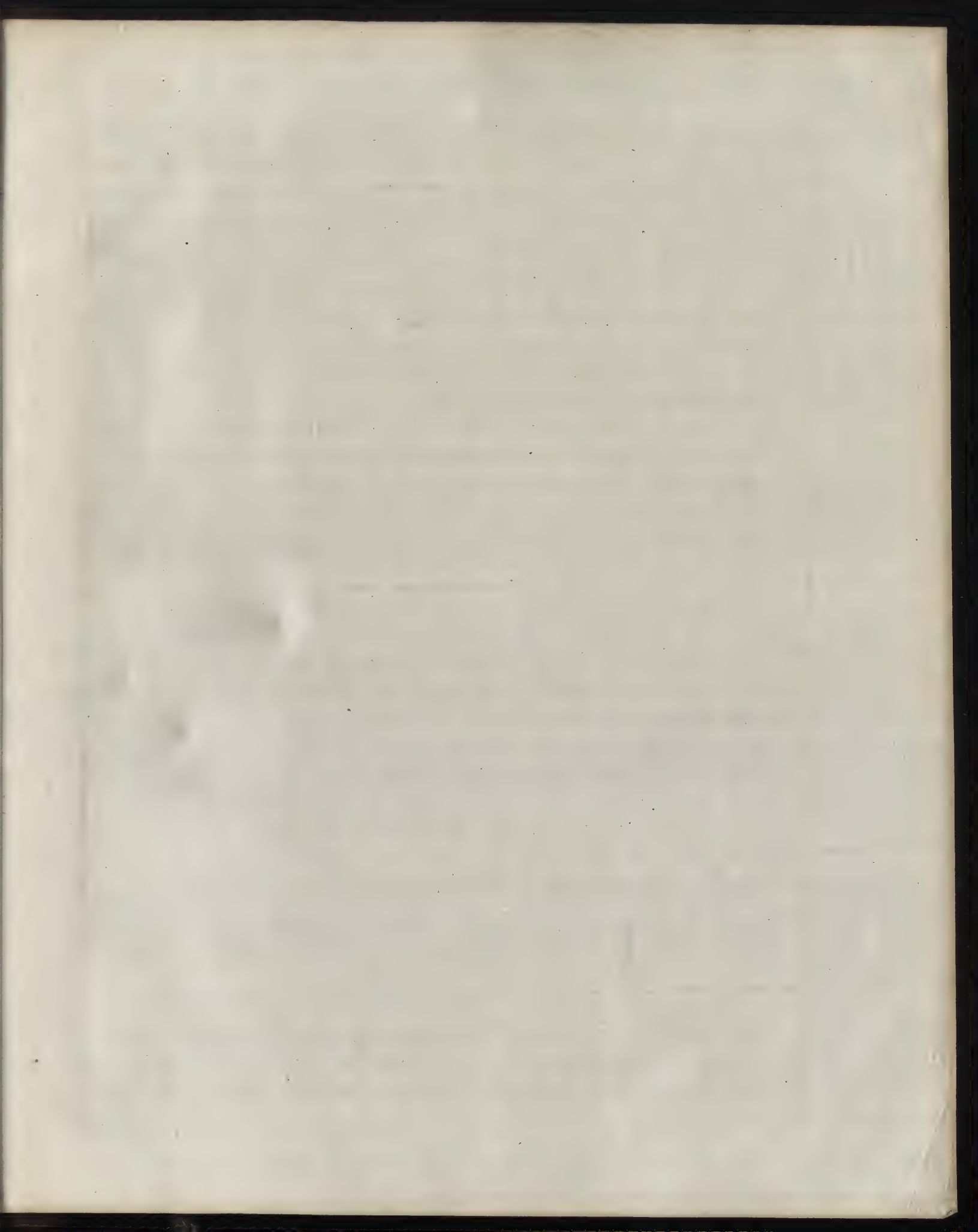
I am confident, and I hope it has appeared evident, that this petrifying Quality is most assuredly one among numerous other most useful Properties, peculiar to Lime-stone; but how this petrifying Quality is to be heightened or hastened in fresh and salt Water, that indeed, is not within my scanty Province to determine; therefore, I most humbly beg leave to recommend it to the study of curious philosophical Gentlemen, acquainted with the Qualities and Operations of Compounds, as I presume there is a great Probability, that these my poor Gleanings may be thereby brought to Maturity, and that by an industrious Cultivation thereof, they may be rendered productive of Utility in Matters of such exceeding great Moment to the Public in general. There are many other Things necessary to mention, but you will find them dispersed through the following Pages.

S E C T. II.

Concerning the building of a Stone Pier in the Sea.

PROP. XII. **T**O build a single Pier-head of Cut-stone in the Sea, the dead low Water at neap Tides being 20 Feet deep, and high Spring Tides rising 20 Feet more.

Previous to our forming these or the like designs, we must consider, that the Tides and the Winds have very powerful Effects, especially when united. Let us therefore, endeavour to find out some certain and general Rules for this Purpose; in order to which,
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it may perhaps, be necessary to observe, that one cubical Foot of Stone, upon an Average, may be supposed to weigh three cubical Feet of Water; but Stone being more ponderous, it will consequently be the more powerful in its Opposition, and the fitter for our Purpose. Let us therefore consider, as for instance: In a still, quiet Lake, you must admit that the whole Weight of the Water, rests and stands upon its own Basis, that is, the Bottom of the Lake; and the Bank, or whatever the Inclosure of it is, sustains very little Pressure by that Water. Let us now suppose, that Part of this Lake is inclosed with a perpendicular Line of 20 Feet high; which is the Height here given for the Tide. See Plate XLVII. *Scale 16 Feet to 1 Inch.* which Line is represented in Fig. 1. by the Line, a. b. Now if you were required to form a Brace, or rather a Stone Buttreffs, to strengthen, and give that Line sufficient Power to keep its perpendicular Situation, so as to be able to support itself and to sustain the Pressure of that Water, to the Extent and Height of twenty Feet, you must lay down another Line of the same Length horizontally, and in right Angles with it, as, a. c. and then draw the hypothenufe, or diagonal Line, b. c. which diagonal Line, b. c. describes the Bounds and Power of a Stone Buttreffs, which will be abundantly sufficient to withstand the Pressure of this Water, or at least equivalent to it; which you may prove thus. Multiply, a. b. by itself, the Product will be 400, and a. c. by itself, the Product will be 400 more, add these two together, and they will be 800; then take off your diagonal Line, b. c. and by your Scale, you will find it near 28 Feet 4 Inches; and multiply that by itself also, and it will be equal to the Products of a. b. and a. c. taken together, insignificant Fractions excepted; whence I think it is evident, that the Power of the Line, b. c. is equal to the Powers of the Lines, a. b. and a. c. and consequently describes the Buttreffs required for a still dead Water.

But now comes on the main Thing. We are not to encounter with a still dead Water, but with the Tide, which is liable at all Times to join in Conjunction with most powerful stormy Winds; but still, supposing that they do not exceed our given Height of 20 Feet, (yet what Strength or Power these Winds and Tides may acquire

acquire when united, is not to be easily determined) but as I told you before, you must form in your own Mind, the most powerful Effects of them imaginable, and thence draw your Conclusions, whereon you must form your Designs; so that your Work may be so substantial, as to withstand their utmost united Forces; and always observing, in Case of any doubt, to keep on the sure Side, throughout the whole Progress of your Works: In order to which, let us return and reconsider the Power which appeared so adequate to the Pressure of 20 Feet high, and 20 Feet broad of still Water. From b. and c. draw two other such Lines, which will meet together in the right Angle, d. which will augment our Figure, and thereby produce an exact Cube of 20 Feet, which of Stone, or our Stuffing, upon an Average, would weigh 464 Tons, one half thereof, being 232 Tons, hath already appeared to be adequate to the Pressure of the Plain, a. b. which is equal to 20 Feet square; the other half of this Cube, being 232 Tons more, makes up a Power, which will certainly be sufficient to sustain the utmost Force of the Tide and Wind, acting together on the Side of the Cube, a. b.

It is evident, that there cannot be any Rule found out, to determine with Precision, the Strength and Powers of the Tides and Winds united. Let us therefore, at present, endeavour to exercise our Reason on the following experimental Supposition, *viz.* Let a Coffin of 20 Feet Cube, the given Height of the Tide be made, stuffed and floored after the Manner herein before, or after directed, and lodged upon any hard level Ground, on the Strand at Low-water mark, the Wind and Tide coming upon this Cube in any Direction, but suppose from the point, e. I presume, that this Coffin will be able to sustain the utmost Power and Force of that Wind and Tide, for as long a Time as Fir Timber being so exposed could be expected to last; but in the present Case, I conclude, however, that this cubical Proportion, would be too scanty for our Purpose, because if the Wind and Tide attack this Cube obliquely, as from the point f. they gain a great Advantage of the Cube, for they will have the Line, b. c. to discharge their united Powers upon: And although the point whence the Tide flows may be determined, yet

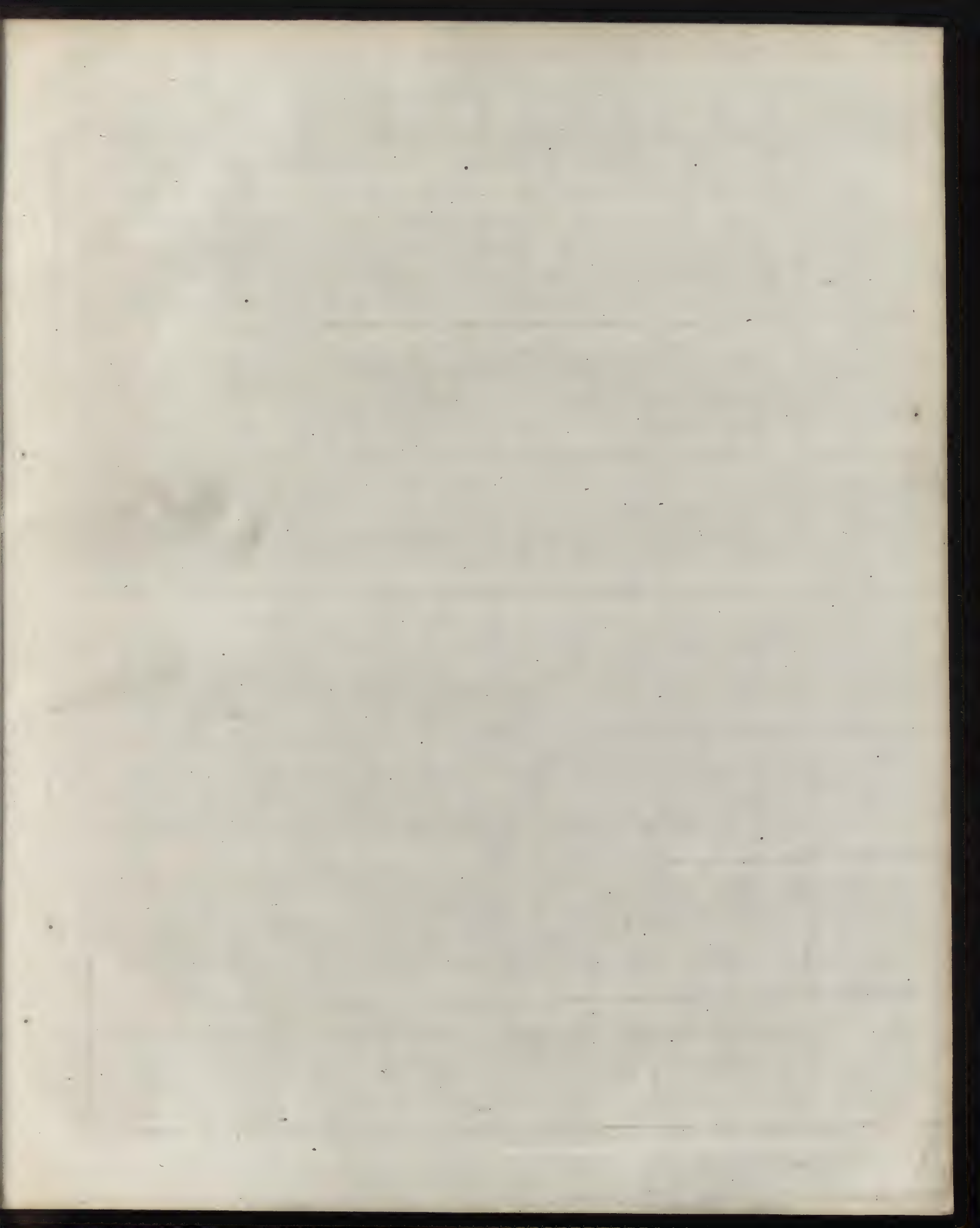
yet the Wind is variable, whence it is evident, that you must not design your Pier upon the cubical, but on the diagonal Proportion. Therefore lay down the Line, b. c. from a. to g. and the Line b. d. is to be extended to h. then draw the Line, h. g. which will augment our Dimensions to about 28 Feet long, and 20 Feet square, and will contain about 11200 Feet solid, at 130 Pounds to the Foot, will contain 650 Tons weight. And so your Pier being designed on this Proportion, every 20 Feet square of such a Pier, would have at least a weight of 650 Tons to oppose the force of the Wind and Tide, that may act upon so much of its front; which is a weight so exceeding great, that I believe there is no considerate Man, but what must allow that this Proportion will be abundantly sufficient, but this shall be more fully demonstrated in its proper Place.

Now on these Principles, let us proceed to design, and consider the Construction of the Body of the Pier; that is, from the given Low-water, to the Surface, or Bottom of the Parapet. See Fig. 2. (by the same Scale) whereby the given Heights are represented; and note, A. Is the Bed or Bottom of the Water, a. the Low-water mark. b. High-water mark. Divide a. b. into four equal Parts: One of these Parts is to be added to a. b. as a moderate Proportion for the Surge, which will then make the Height a. c. = 25 Feet, for the Height of the Body of the Pier. Then (see Fig. 3. by the same Scale) draw your Base Line, a. q. and intersect it with your Center Line, g. e. take the Height, a. c. which is 25 Feet, and add 6 Inches to it for the 24 Joints of Mortar, and set it off from e. to d. and thereon form the square, d. e. f. g. from f. to e. draw the Diagonal, f. e. which by your Scale, you will find to be near 36 Feet. This Diagonal may be looked on as a reasonable Base for the naked Body of the Pier, which you must divide into two Parts, and lay them down from e. to h. and from e. to i. and so having the Base and Height determined, draw the parallel Line, f. e.

You are also to consider, that this Base Line of the Body of the Pier, cannot begin at h. i. in the Execution of the Work, because the Hull of the Coffer must rise three Feet above this dead Low-water

water mark, a. And that the three projecting Courses, on which the Body of the Pier is to stand, will take up three Feet more; and for these Reasons you must transfer h. i. to s. t. which is to be the naked Base of your Pier, and subtracting 6 Feet out of h. l. (= 25 Feet 6 Inches, the last given Height) there will be 19 Feet 6 Inches remaining for the Height of the naked Body of the Pier. u. g. Which you must divide into 6 = Parts, as at t. k. and take one of these Parts, and set it off from k. to m. and do the like with the opposite Side l. n. and this gives you the true batter, or diminishing of the Pier; by which Method, you are to cut the bevil Moulds for the Stone-cutters, and the battering Plumbs for the Setters, &c. and deducting l. n. and m. k. from s. t. there will remain n. m. = 29 Feet 6 Inches for the Breadth of the Body of the Pier at the Top, just under the first Course of the Parapet, which to avoid Fractions (which are not necessary here) we shall call 30 Feet, and this furnishes you with the principal Dimensions of the naked Body of the Pier; that is to say, the Base s. t. = 36 Feet, the Height u. g. (you know was 19 Feet 6 Inches, but we shall call it) 20 Feet, and n. m. 30 Feet, and so 36, 30 and 20, are the principal Proportions for the naked Body of the Pier, for a Flood-tide of 20 Feet, exclusive of the three projecting Courses and the Parapet, and including the whole together. Remember, that one Foot long of this Pier (which you will find represented in Plate XLVIII. Fig. 1.) will contain 817 solid Feet, and 20 Feet running Measure of the same = 16340 Feet, at 130 Pounds to the Foot, will be 948 Tons: And so you see that every 20 Feet long of the Pier, will have 948 Tons Weight to oppose the Power of Wind and Tide, acting upon the front of that 20 Feet long. And this I am sure will be abundantly sufficient to oppose them; and this Calculation will also be useful to you in making your Estimates, &c.

All these Matters being supposed to be clearly understood, let us in the next Place, consider the Proportions of the Coffers for the Body of the Pier. Draw the Line, x. y. parallel to r. q. take the extent s. t. and set it off from e. to p. and from e. to o. draw the Lines p. v. and o. w. and p. o. v. w. gives you the Extent of the Coffers for the Pier. Then to proportion the Coffers for a single Strait-



Pl. 48.

F. 1.

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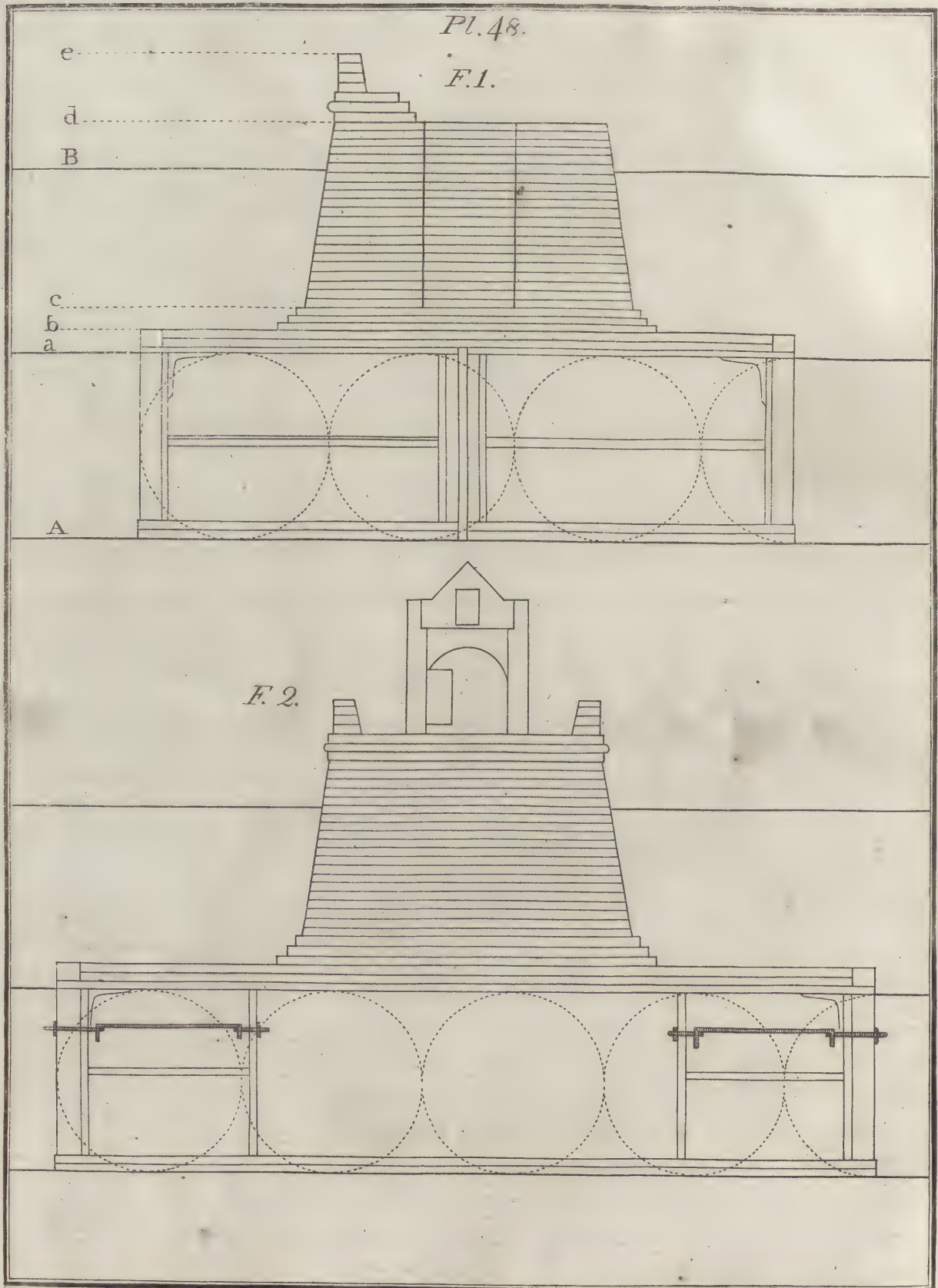
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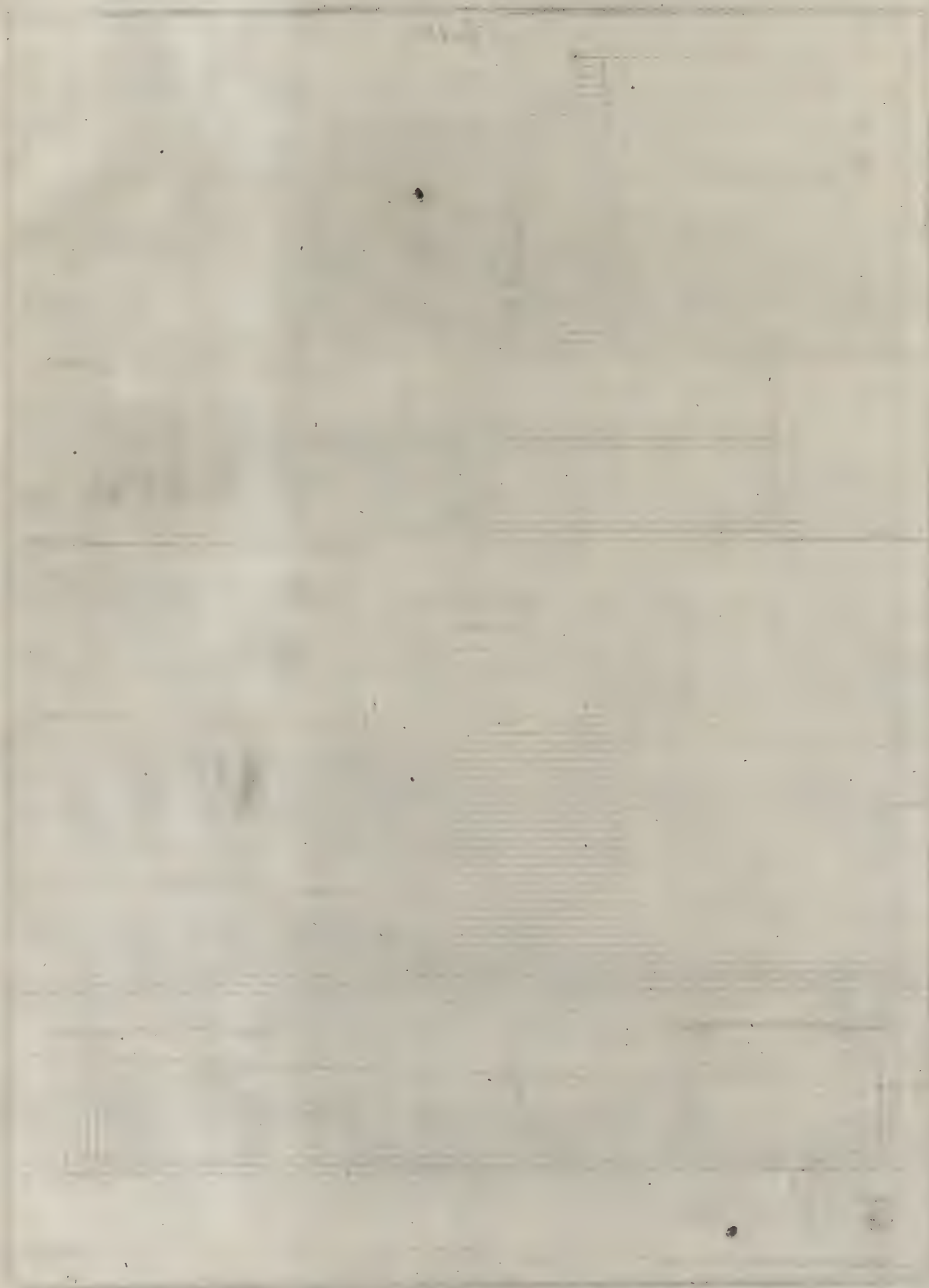
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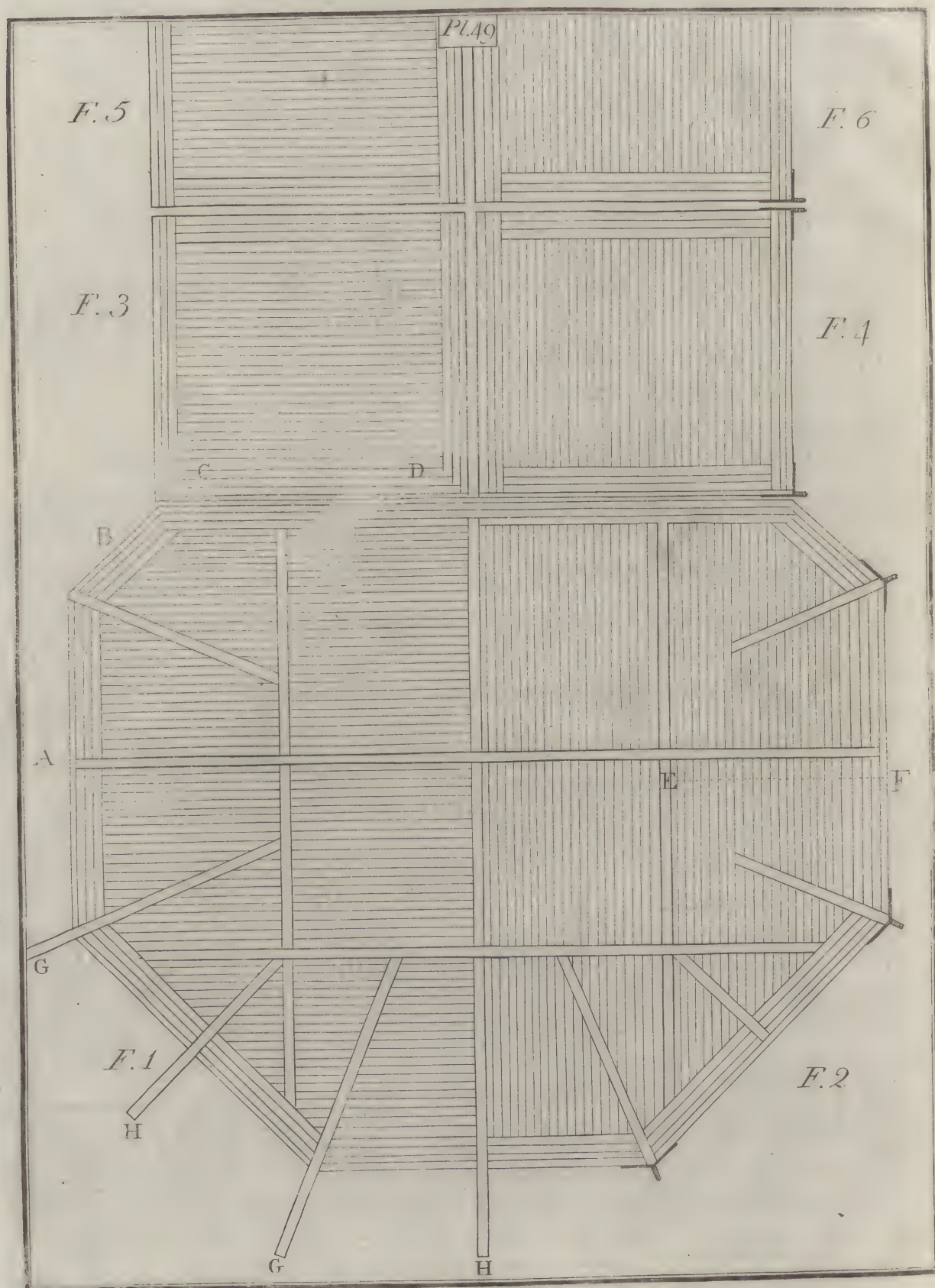
a

A

F. 2.







Strait-pier Head, divide s. u. into two = equal Parts, and lay down one of them, from p. to r. and the other from o. to q. draw the Lines r. x. and q. y. and r. q. x. y. shews you the Extent of the inner Coffers for this Pier Head, the Guard-coffers being referred to their proper Place. Then, to determine their Height, divide u. t. into 6 = equal Parts; one of these Parts, added to the given Height A. a. gives you x. z. = 23 Feet for the Hull or outward Height of these Coffers. Thus you may augment or diminish the proportions of your Diagram, according as the various Circumstances that may attend your Design, may respectively require. Now let us collect and lay down these principal, and the more minute Dimensions in something of a regular order.

Plate XLVIII. (*Scale 16 Feet to 1 Inch.*) Fig. 1. represents the Section of the Pier compleat, and standing as if it were erected upon its Coffers (which extend three Cubes and a half of Low-water). Wherein note, A. Bottom or Bed of the Coffer. B. High-water. a. Is the Low-water mark. b. The Top of the Hull. c. Base of the naked Body of the Pier. d. The Bottom of the Parapet, or Top of the naked Body of the Pier. And, e. (which you see also comprehends the Plinth and Cord) gives the Height of the Top of the Parapet, which together make 7 Feet or about $\frac{1}{3}$ of Flood-tide, which is a proportionable Height to keep off the Spray; which added to the five Feet before allowed for the Surge, makes 12 Feet above the given Height of a Spring-tide, which you may increase or diminish at Discretion. Fig. 2. Exhibits the Section of the Pier-head, standing upon its Coffer (which extends four Cubes and a half) the Height of which you see is the same as above. The Superstructure or small Building on the Pier-head, will be hereafter fully delineated along with the other Parts of the Work.

Plate XLIX. (*by the same Scale*) Fig. 1. Represents half of the first Course of the Hull and Grating for the Coffer of the Pier-head. Fig. 2. The second Course of the same. Fig. 3. The first Course of one of the Coffers for the Pier. Fig. 4. The second Course of the same. Fig. 5. and 6. Shew you $\frac{2}{3}$ of the next Coffers for the Pier: On all which I shall only now remark, that all the principal Beams in both these Courses, are to lie exactly over one another,

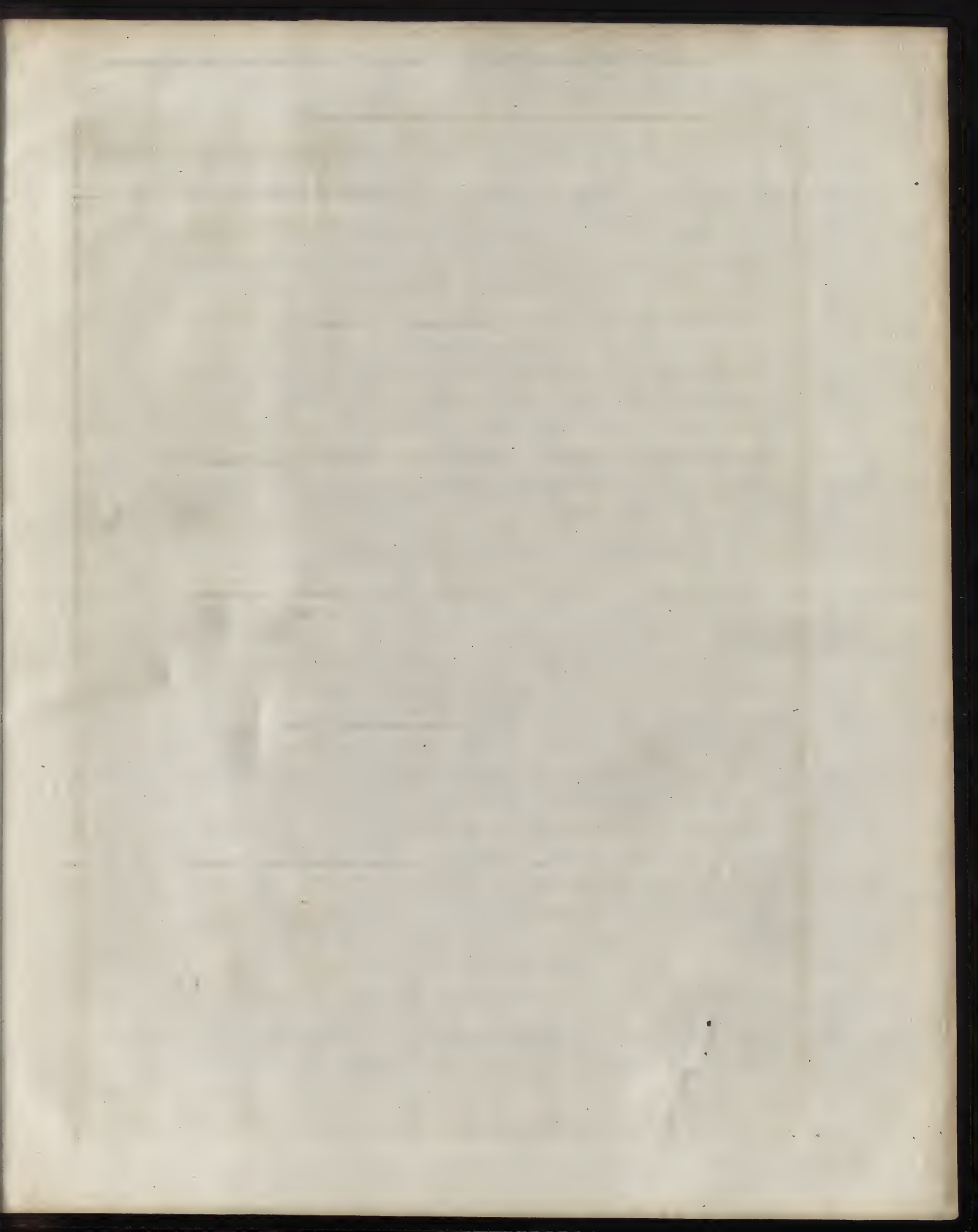
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and to be keyed and bolted together, breaking Joints according as the different Length of your Timber will admit, as formerly directed, on the last Proposition.

I have observed above, that I am very little acquainted with marine Affairs, and for want of that Knowledge, I must confess that I am at an entire Loss to determine, whether this Coffin for the Head of the Pier, had best to be in one or in two separate Parts. You see the conjugate and transverse Diameters are equal to about 90 by 76 Feet, which really is an enormous Size: And therefore I shall not fully determine this Point; but I advise you, that after you are determined as to the Situation of the Pier, and considered the various Circumstances relative to it, you may lay down these Draughts by a larger Scale, or make a model of the Coffin by a Scale of one Inch to a Foot, and thereon take the Opinion and Advice of some eminent Ship-carpenter, and ask him this plain Question; Whether it is practicable to launch and settle so large a Bulk in the Place destined for it? And on his, or other Mens Opinions, you may determine this point. For this appears to me the sole Difficulty, that can in any Ways attend this whole Work; and yet I cannot help thinking, that if it be built in a convenient Place, and a proper Quay made for launching it, as before mentioned, that in one calm neap Tide it may be grounded in its Place, and then all your greatest Difficulty will be over; but against that critical Time, take the utmost Precautions to have your Crafts ready loaded, and every Thing necessary to crowd in your stuffing, to keep it down when it is grounded. But notwithstanding the Hurry you will at that Time be in, be sure that your stuffing be properly mixed together, for if they throw Stones in one Place, and Lime and Sand in another, the latter will indeed petrify, but the former cannot, which you may easily accomplish by the Precautions I have already given you concerning the stuffing. Your best endeavours and those of your Workmen, are absolutely necessary at these critical Times, in working as the Tide answers, both Night and Day, at Night by the help and Direction of your buoy Ropes, till you fill it to the upper Timber.

Upon



Pl. 50.

F. A.

F. 5

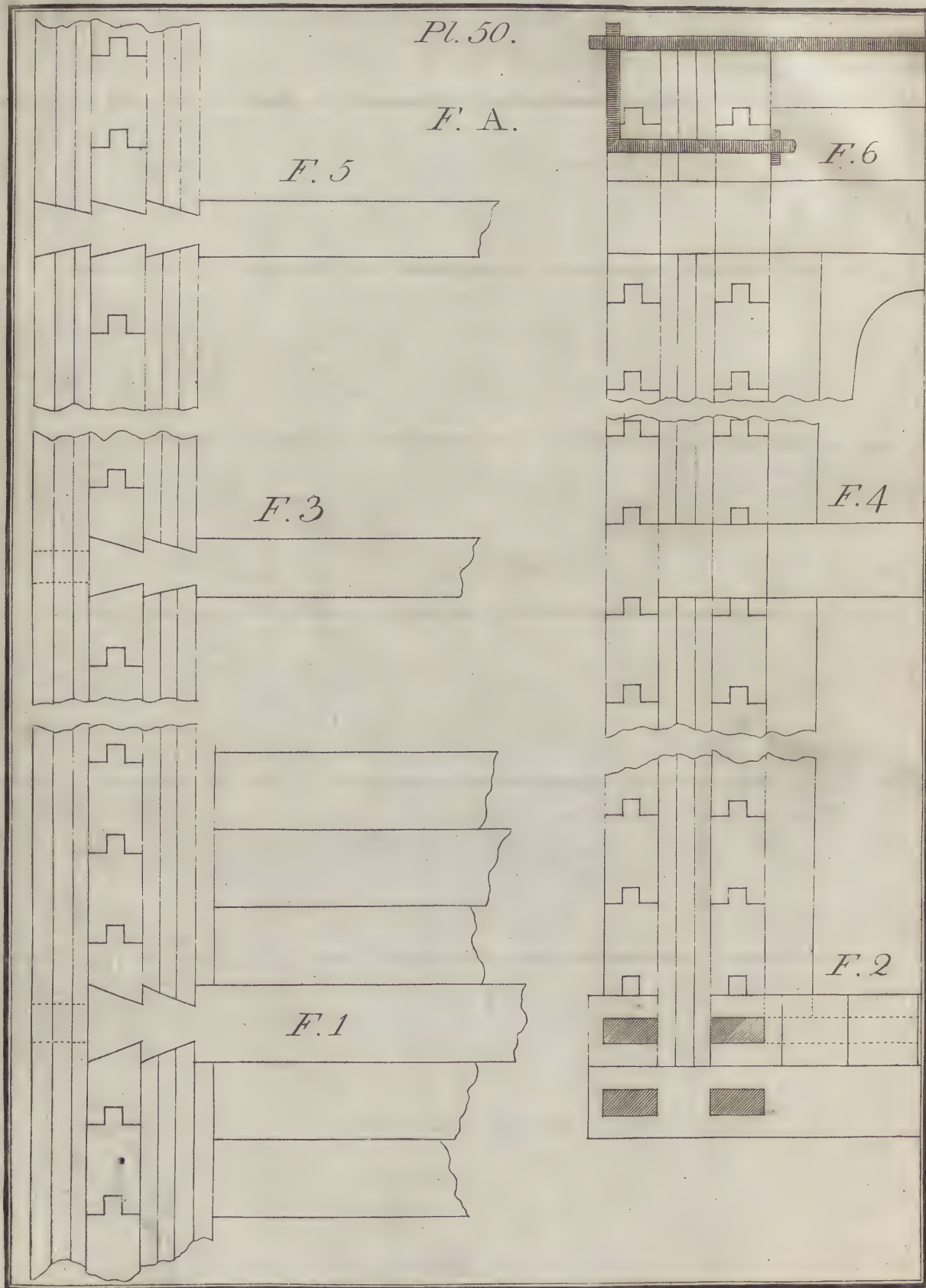
F. 3

F. 1

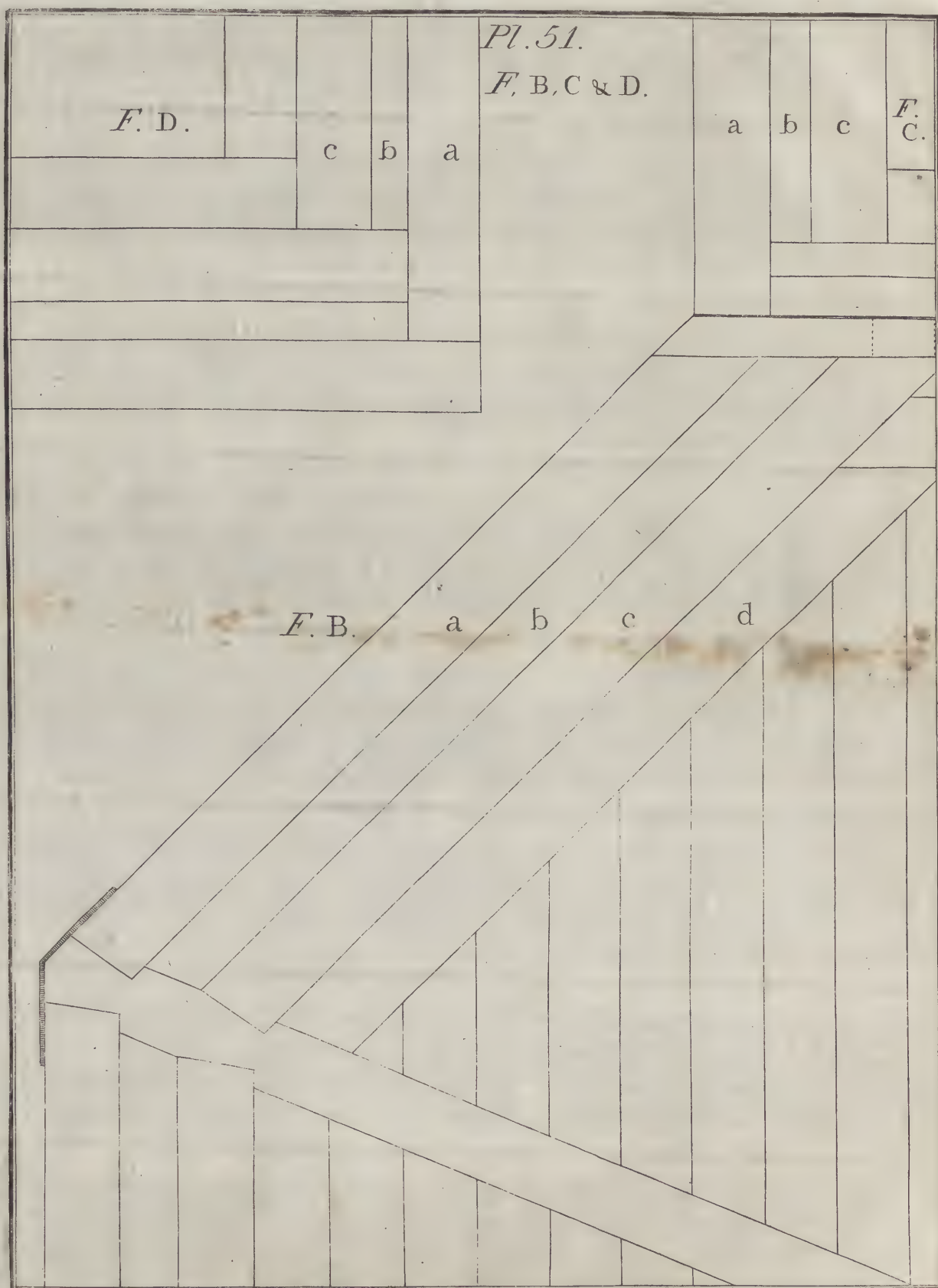
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F. 4

F. 2







Upon these and other Considerations, I have designed this Coffor entire, as being by much the more eligible Way; on which you may further observe, that part of this Coffor opposite to A. is explained in the next Plate. The first Course of B. C. and D. in Plate LI. The second Course of the same in Plate LII. And a Section at E. F. Plate LIII. Also observe, that in Case you think it necessary to have Sea-braces (as was fully described Plate XLVI. Fig. 1. Letter I.) you are to extend the four principal or diagonal Pieces, that will be next to the Sea, ten Feet each, as at G. whence spring the four Sea-braces; and if you think all that will not be fully sufficient, you may also extend the Ends of the Middle-fills in like Manner, as you see at H. H. and let Braces spring from them likewise.

Plate L. Fig. A. (*Scale 2 Feet to 1 Inch*) Fig. 1. Shews the Plan of that principal Beam united to the Hull. Fig. 2. Shews the Section of the same. Fig. 3. Shews the Plan of the Middle Brace-beam, going through the Hull. Fig. 4. Section of the same. Fig. 5. Plan of the upper Brace-beam; and Fig. 6. Section of the same, and the Manner of cramping the Hull and the Cut-stone together.

Plate LI. Fig. B. C. and D. (*Scale 2 Feet to 1 Inch*) Fig. B. (as in Plate XLIX.) Shews the first Course of the Ground-work. Wherein note, a. Out-side Timber of a Foot square. b. A vacant Space of 9 Inches wide, left for the Tennon or upright Piles to stand in. c. Another Timber of a Foot square. d. The Beam into which the Ends of the first Course of the Grating is to be let in by a running Mortice; but I believe it might answer full as well, and be much more expeditious, and save a great deal of Timber, by spiking and pinning on four Inch Scantling, to make a Groove for them. And on second Thoughts, I believe that (in Plate XLIX.) it would be advisable to do the same with all the principal Timber in both Courses of Fig. 1. and 2. Fig. C. Shews the Ground-work of the out-side of the Coffor for the Pier. Wherein note, a. Outside Beam. b. Vacancy for the 6 Inch upright Piles, and c. Inside Beam. Fig. D. Shews the inner Angle. a. Is the Beam. b. Vacancy; and c. Beam, &c.

Plate LII. Fig. B. C. D. (*same Scale*) Shews the second Course of the Grating, and the Plan of the Hull compleat; but observe, that all the corner Posts, *viz.* a. b. c. are to be made of Oak; and that the six Posts E. are to be made of the same in two separate Parts, and bolted and keyed together, as was fully described in Plate XLV. Fig. 3. with only this Difference; that the Thickness of that Hull was three Times 8 Inches, and this three Times 9 Inches.

Plate LIII. Fig. E. F. (*Scale 4 Feet to 1 Inch.*) That you may clearly comprehend this Plate, turn back to Plate XLIX. and in Fig. 2. Observe the dotted Line E. F. which you also see here laid down by this Scale, delineating the compleat Section of that Part of the Coffer, with the Plan underneath it, and by your comparing it with Plate XLVIII. Fig. 2. you may fully comprehend the Construction of this Coffer, together with what I've already exhibited. However note, that H. is the Bottom of the Water, and represents also, the Sill that extends to receive the Sea-braces, provided you have no Guard-coffers. I. The Bank, which you may extend at Discretion. K. Is the dead Low-water mark; and L. shews the Height and Rake of the Sea-braces, which may be applied here, or reserved for the Guard-coffers, and may either be double or single, just as the Situation, or other Circumstances may require: And here please to observe, that as you now know the Use and Method of making the Sea-braces, you may also occasionally introduce the like in flat-bottomed Coffers; but particularly, they may be of very great Advantage in strengthening, such as are made for Tongues, Quays or the like, either in the Sea or in Rivers.

Plate LIV. (*Scale 16 Feet to 1 Inch*) Gives you the Plan and framing of all the upper Brace-beams, exclusive of the Iron-work, which you see applied to the like Purposes in Plate XLV. Fig. 2.

Plate LV. (*same Scale*) Represents these Coffers compleatly stuffed and floored with the Cut-stone, and cramped with Iron; in which remember, that every Cramp must extend to the second Course of Stone at the least, and when this Work is so far accomplished, you may proceed with the rest of the Coffers of the Pier, and leave the Coffers of the Pier-head in this secure Condition, during

Pl. 52.

F D

F. B, C, D.

F
C.

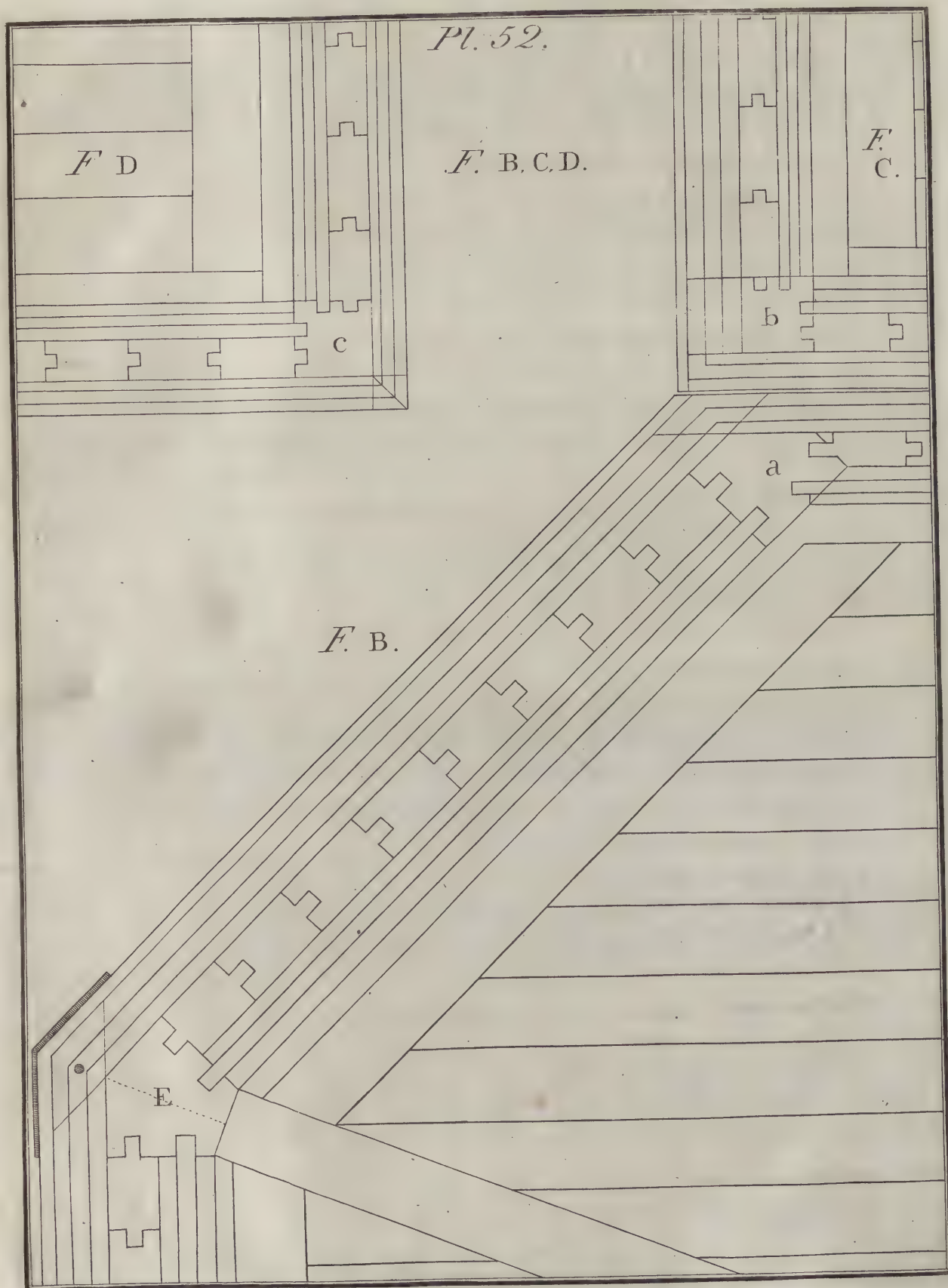
b

c

a

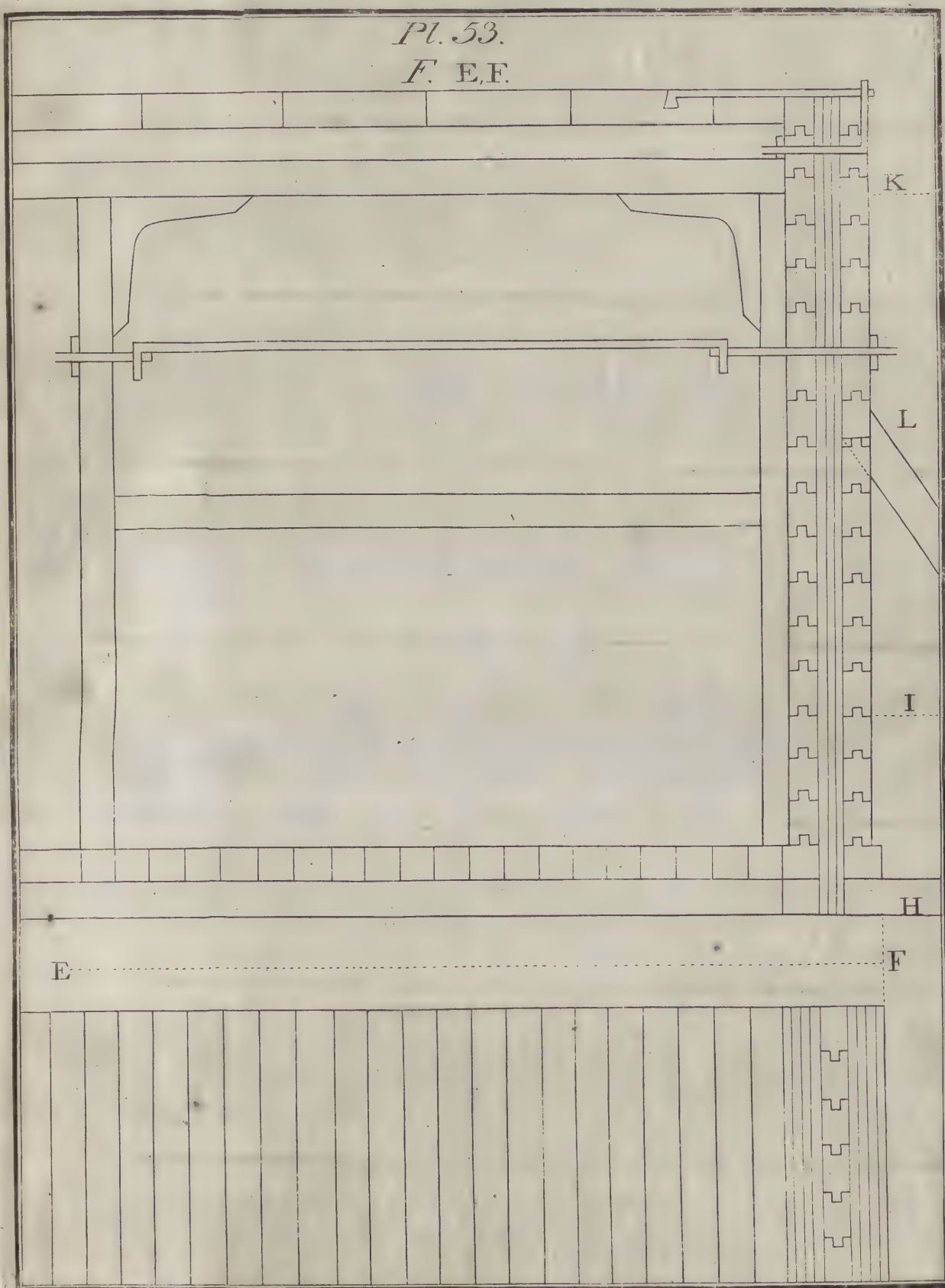
F. B.

E



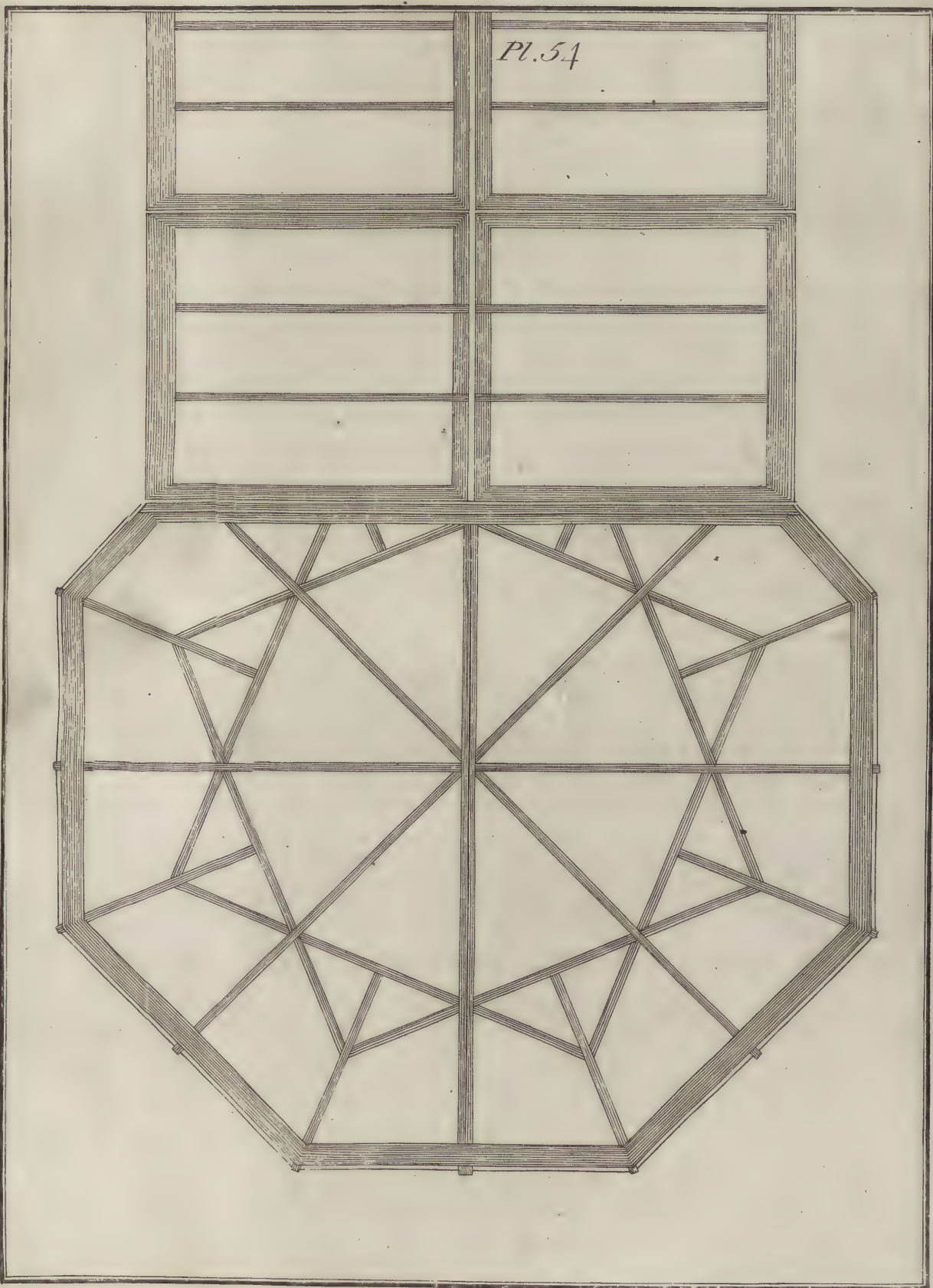
Pl. 53.

F. E.F.



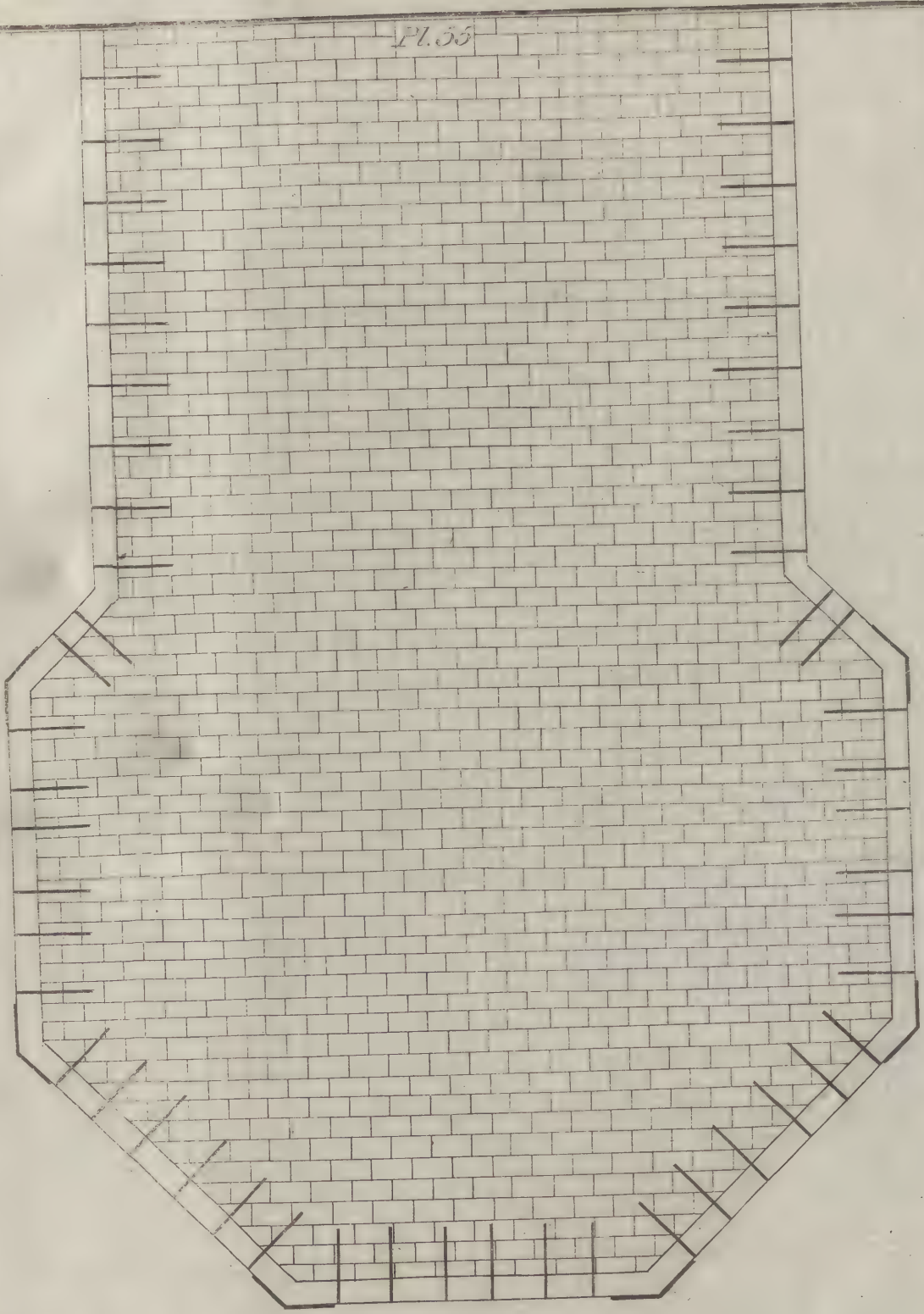


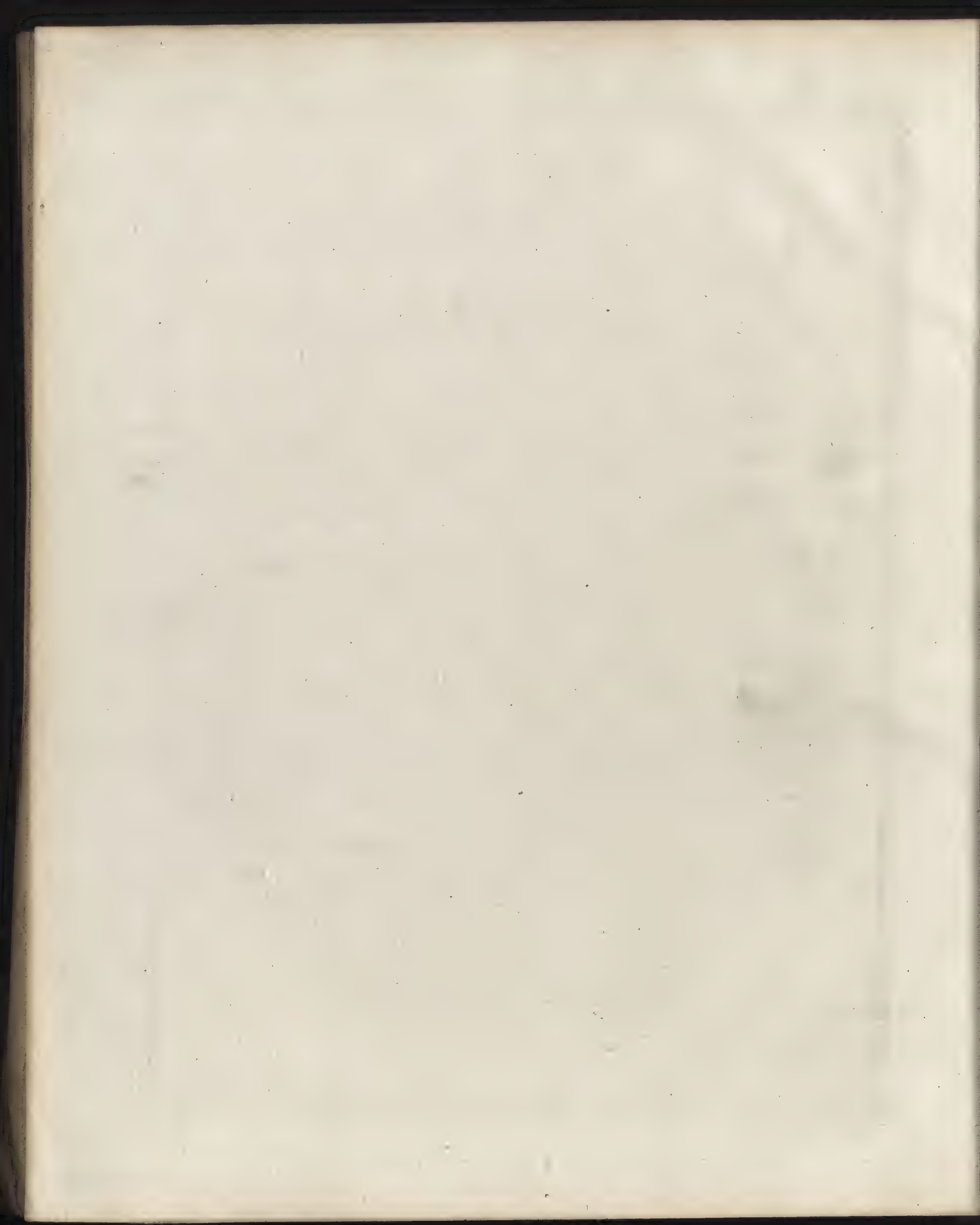
Pl. 54

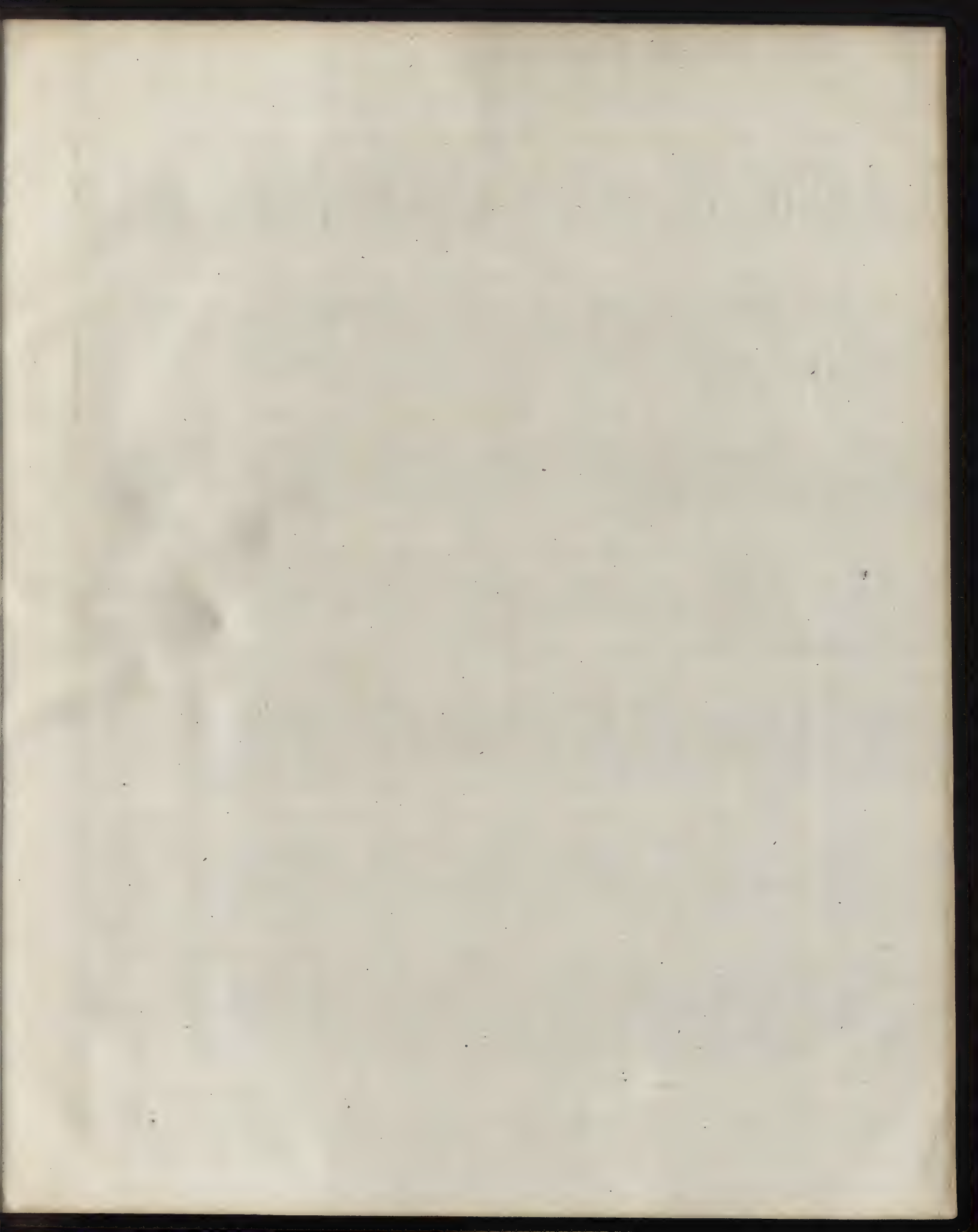


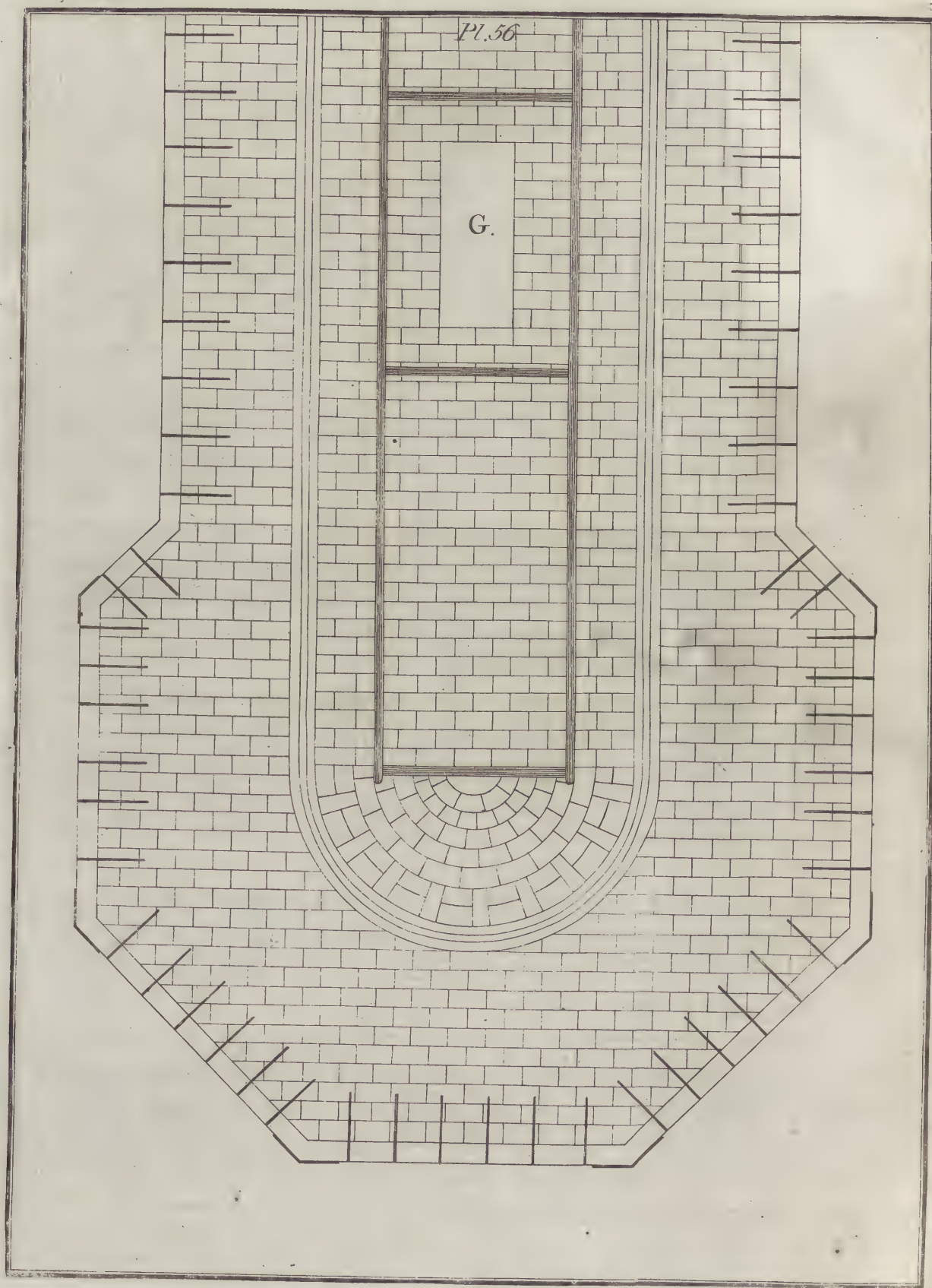


PL 55









during Pleasure. Observing also, that after the same Methods of Construction, you may augment or diminish the Size, Shape or Strength of other Coffers, proportionable to any other design or purpose according as their various Circumstances may require, or as your own Reason may direct.

Plate LVI. (*same Scale*) Represents the Plan of the fourth Course of the Pier-head, built on the Platform, with the Timbers that are to be framed together, and Chain-barred as formerly directed; and the like Timbers are to be repeated at about High-water mark: And observe, that the Coffer which you see left in the Stone-work of the Body of the Pier, G. is to be filled with stuffing, 'till you come to the Platform.

It may also be necessary for you to observe, that so much as you here see drawn of this Pier-head, is drawn as if the whole was to be wrought with Blocks of Cut-stone; yet, I do not by any Means recommend that as absolutely necessary, for the Remainder of the Body of the Pier, except you have such Stones very cheap; but by all Means, let the Headers, Stretchers and Tail-bonds, especially in the Side next to the Sea, be done with such Cut-stone as we have hitherto recommended; but the interior Work will answer effectually, if it be built with rough Stones carefully laid in swimming Beds of good Mortar and grouted.

I know there have been very eminent Gentlemen, who warmly recommended a peculiar Method of cutting the Stones for the outside Work after this Manner, *viz.* To double Dovetail all the Headers, and to fit the Stretchers to fall in between them, and so lock them into one another; but I do not advise you to follow that Method, because it will be tedious, troublesome and immensely expensive, and of little or no Advantage to the Duration of the Work, for this material Reason: *i. e.* The Wind, and the flux and reflux of the Tide, do operate and principally exert their Power on the Foundation of the Pier and Pier-head, and not on the Body of it, especially, if it is built in shallow Water. On which I shall give you a full Demonstration in the next Section; nor do I think it absolutely necessary for you to finish the outside of the Work neither, in plain Ashlers or in rustic Work, except
you

you do it for the Neatness of it: It may very well suffice, to cut the Stones square in the usual Way in Foot Courses, and in every Course to make a two Inch set off, which with the help of the battering Plumb, will preserve the diminishing of the Pier, and keep it out of winding, and though it will look a little rough to the Eye, yet it will be very effectual.

Plate LVII. (*Scale 8 Feet to 1 Inch*) Furnishes you with a Plan of the Superstructure of the Pier-head, surrounded with the parapet Wall, on the level of the third Step above the naked Body of the Pier, (which was represented in Plate XLVIII. Fig. 2.) Wherein note, a. Store-room. b. Stair-case. c. A necessary under the same. d. Sewer to be carried out under the Cut-stone Floor. e. Bed-chamber for the Lamp-lighter, &c. f. For his Provision, Coals, &c. G. The three Steps before-mentioned, the first of which terminates the Parapet on the Rear of the Pier.

Plate LVIII. (*Scale 8 Feet to 1 Inch*.) Fig. 1. Plan of the Stairs, Oil-closet and the Balcony. Fig. 2. Section of the Hall and Oil-closet. Fig. 3. Section of the Store-room, and half of the Door into the Balcony, the Parapet being omitted.

Plate LIX. Fig. 1 and 2. (*Scale 4 Feet to 1 Inch*.) Exhibits the Plan and Elevation of the Balcony illuminated. Fig. 3. (*Scale 1 Foot to 1 Inch*.) Is the Section of one of the Globes, which must be made of very thick white Glass; and though I do not take upon me to determine, whether Semi-globes, or common square Lamps, will prove most commodious for your particular Purpose, yet I will venture to say, that any of them will be preferable to Coal-fires, for many substantial Reasons, that will quickly occur on a little Consideration; but as I have mentioned Semi-globes, I shall give you my Opinion of them, and whence I conceived my Notion of one sort of them. For some particular Uses I had different sets of Moulds made of cast Brass, set in Frames of Iron; and at a Glass-House in *Southwark*, I had them filled with the hot Metal; and they took the form, and answered my Purpose effectually. Hence I conclude, that you may easily get concave and convex Moulds made, that will admit of the Metal to be three Inches thick at the least in the Semi-globe; and the convex Mould is to be pressed down

G

f

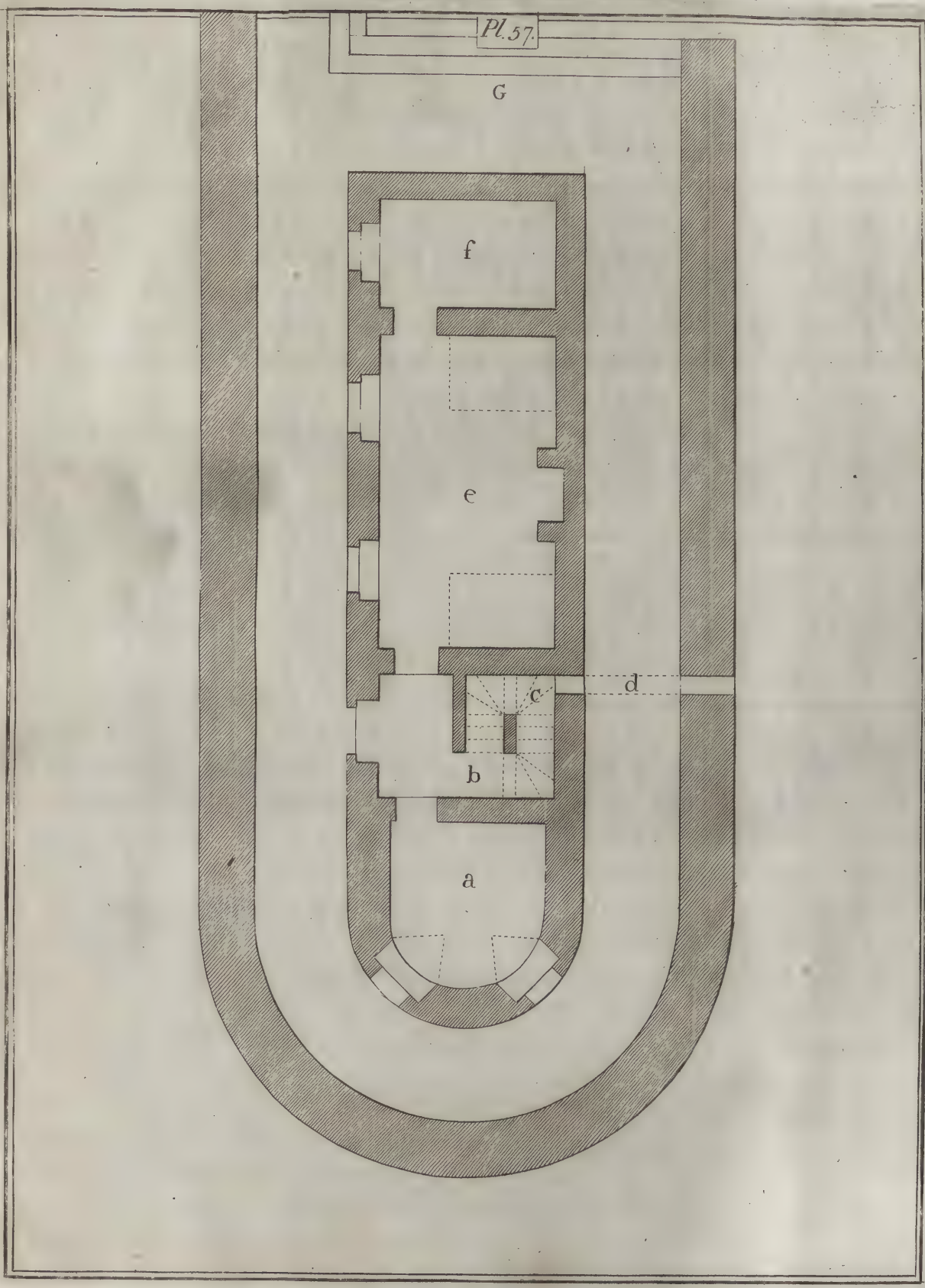
e

b

a

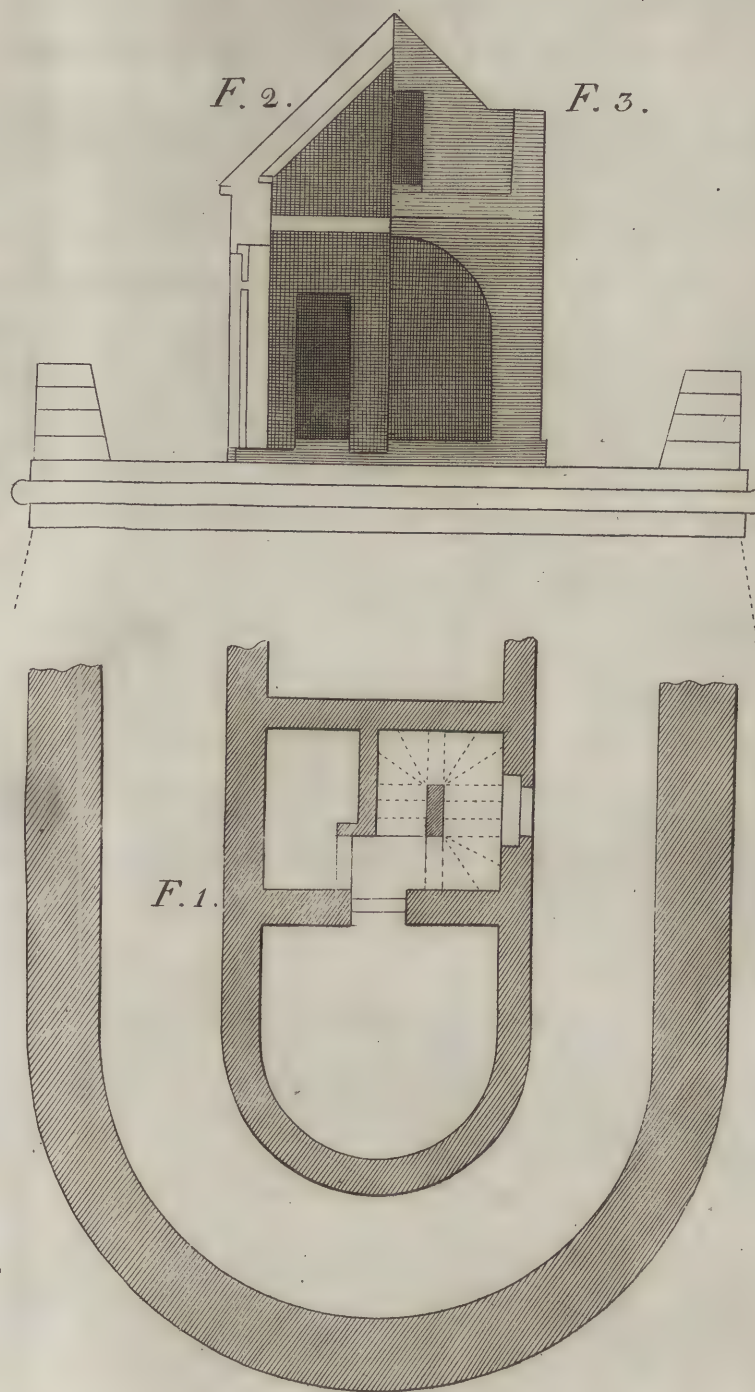
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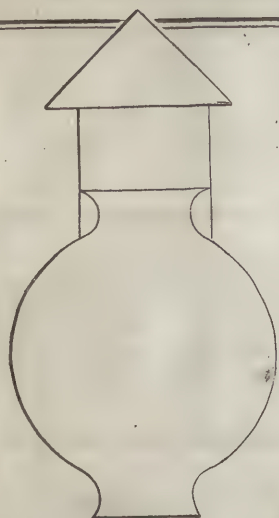


Pl. 58.

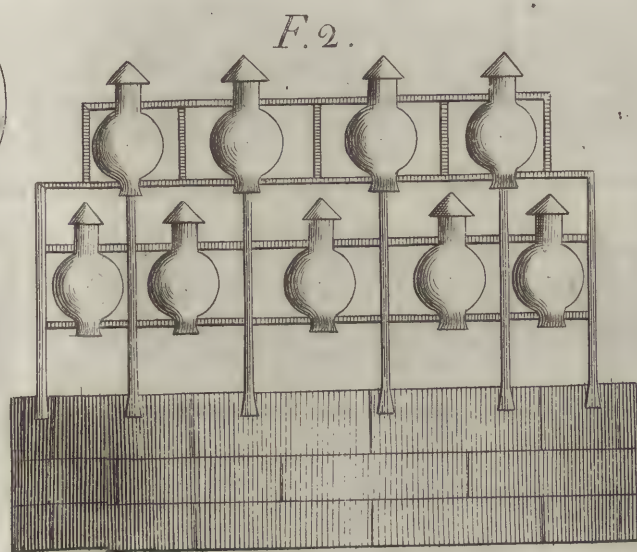




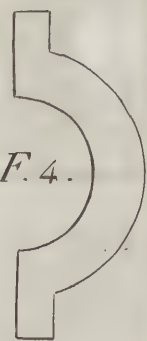
Pl. 59.



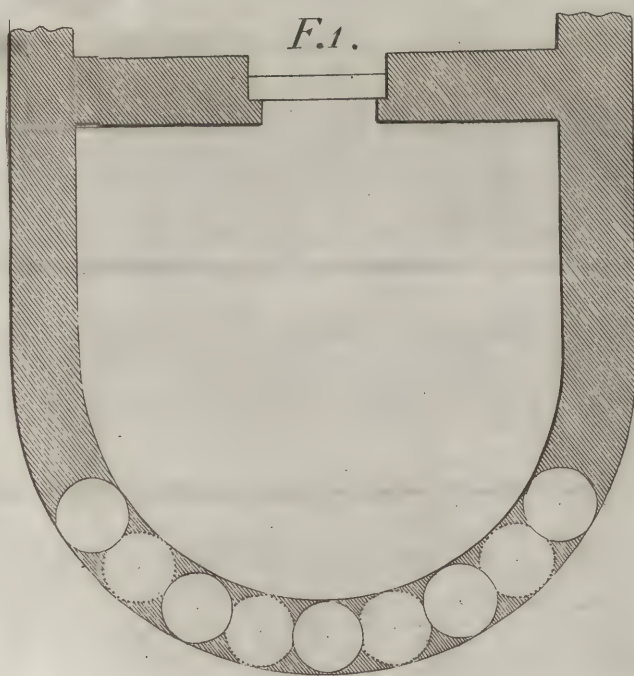
F. 3.



F. 2.

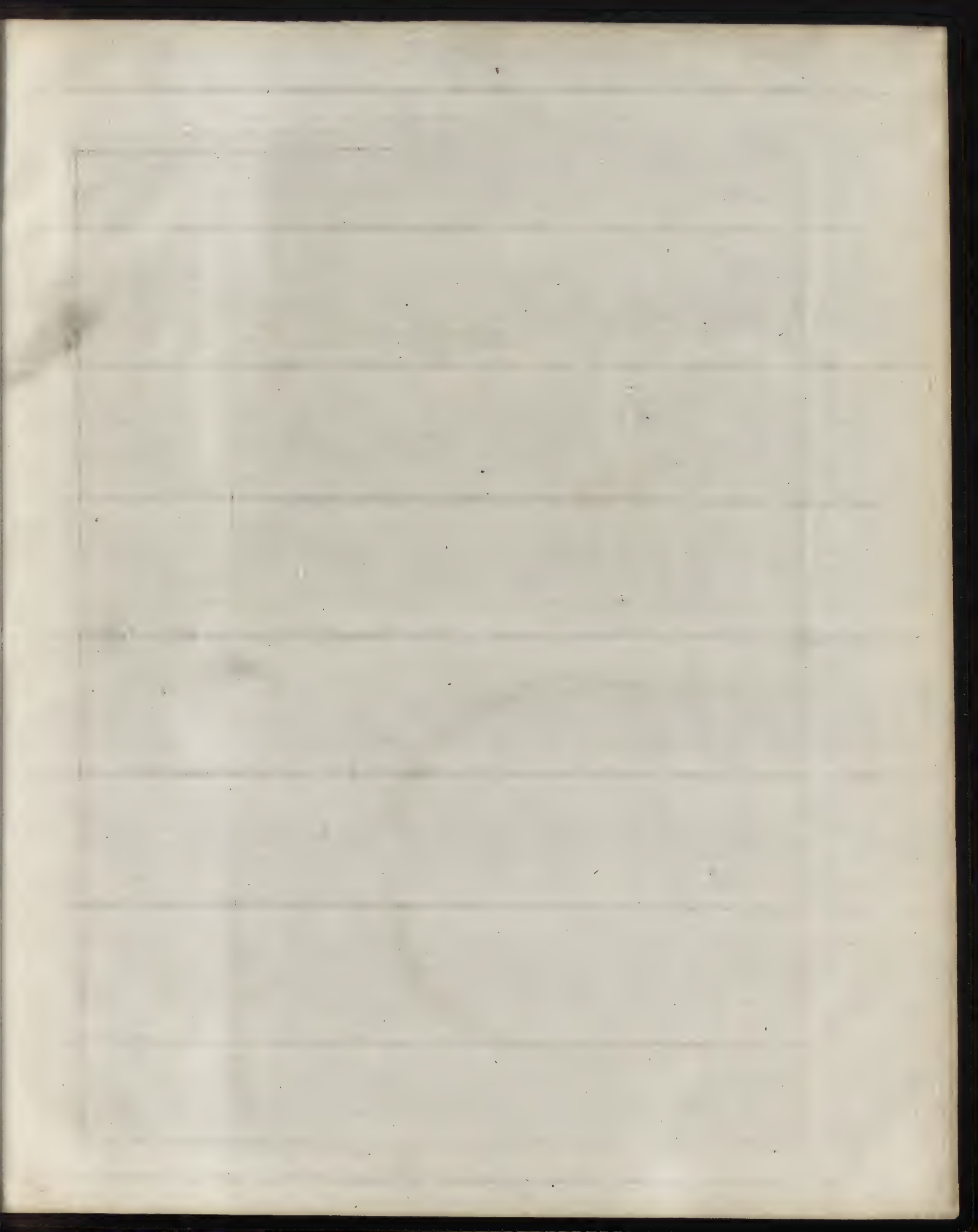


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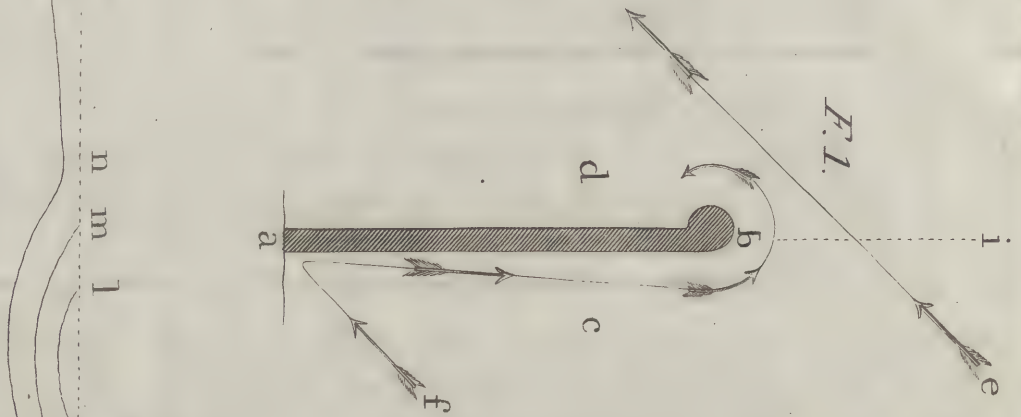


F. 1.

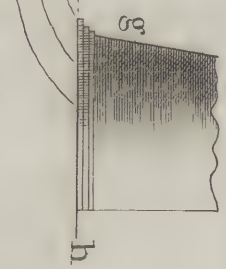




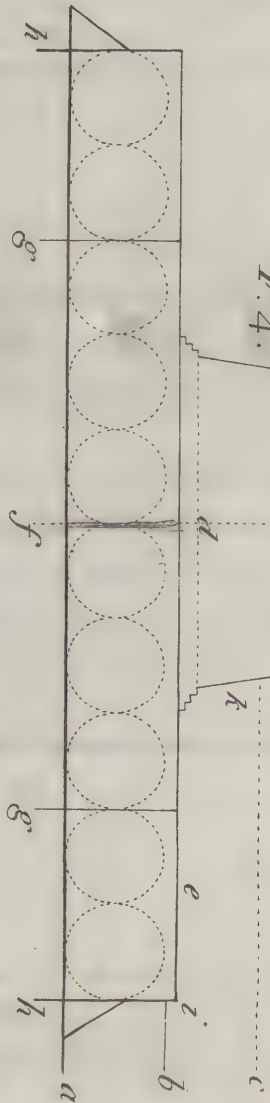
F. 1.



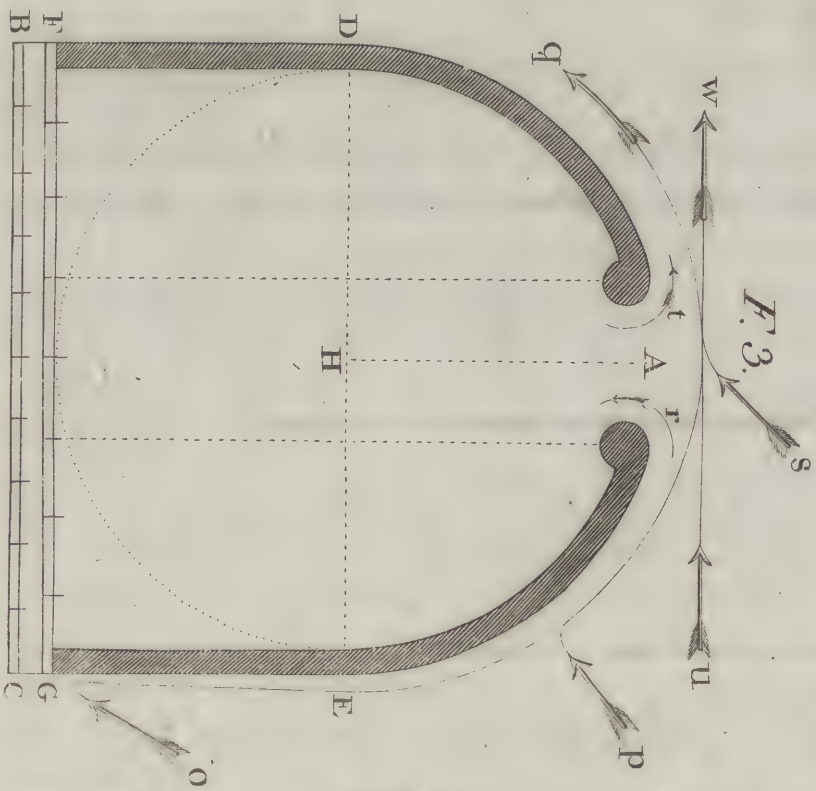
F. 2.



F. 4.



F. 3.



down with a Leaver into it: See Fig. 4. (*Scale 1 Foot to 1 Inch.*) Shews you the Section of this Semi-globe; and they may all be set in Iron Frames, leaving what room you please for your Lamp to stand in behind them; which I think may be very small, for even the light of a small Wax-candle placed in the Center of it, cannot fail of producing, to all appearance, a very luminous Ball of Fire, whose powerful Rays must needs be very conspicuous, especially if the Glas is clear and well polished. And what then must the whole Illumination be with nine such Semi-globes, extending near 12 Feet and 5 Feet high, all as if it were one Body of Fire, that will require very little Care or Expence to support it, nor the least danger of its disappearing through neglect, and thus you may, if you please, illuminate both your Light-house and this Pier-head, and make other useful Improvements on these few Hints. Let us now consider the Operations of Winds and Tides.

S E C T. III.

Observations on the separate Operations and united Powers of Winds and Tides, acting upon the Heads of strait and curved Piers; built in the usual Way at or near Low-water mark.

I HOPE we have fully considered and determined on the Power of the Wind and Tide in general: Let us now in a more particular Manner, observe their Operations upon the Head of a Pier, that is run out from the Shore in a direct Line, and built on a Bed of fine Sand at Low-water mark as usual. See Plate LX.

In Plate LX. Fig. 1. Note, that a. Is the springing of the Pier from the Shore. b. Represents a double Pier-head, which you may observe is much stronger than the former. c. The open Sea. d. The Harbour. e. The Current of the Flood-tide running by b. into d. And f. the Current running along the Shore to a. The Drifts of all these Currents are represented by Darts; by which you may observe, that the Current f. finding itself opposed by the Pier, which directs and guides it to b. in order to supply d. and during its Progress, it is pressed forward by that which comes in the

the like Manner behind it; and also meeting with fresh supplies from the intermediate Currents, it thereby increases its Power, and quickens its Velocity, in proportion to the Length it runs, till it meets with the Current e. on which a violent Contest ensues, each striving for Superiority; but e. being much more powerful, soon obliges f. to yield, and presses it severely against b. where they unite, and if such a Pier was built at the Mouth of a large Tide-river, and the Tide flows up for many Miles into the Country, the further it is to run the greater Quantities of Water wheels round it, and consequently, the greater will the Velocity be at the Pier-head, where it saps and preys on the Bed of Sand on which it is founded; and at the same Time the Water carries every Thing with it, that its Power is able to conquer. The alarming Effects of this may easily be discovered by Fig. 2.

In this Fig. 2. g. represents the extreme Part of a Pier-head, built upon the Sand at h. which is Low-water mark. The fatal Effects of the Current before-mentioned may be perceived by the Curve-line l. which represents a great Cavity, worn away and carried off by the two Currents e. and f. from about the Extremities of b. In order to prevent this, and preserve the Pier-head, it has with some been customary in the like Cases, to throw down large Stones round it, supposing they would preserve it; but let us in the next Place, consider the powerful Effects of the Wind and Tide acting in Conjunction on the Stones and Pier-head, g.

We need not enlarge on the usual Swell of the Sea; but let us briefly reflect on the Power of an enraged Sea, agitated by a violent Storm; and suppose a Wave advancing from f. toward a. Fig. 1. where the Pier gives it a powerful Repulse, and directs its Course to b. and so advancing along the Pier, a second Wave in like Manner pushes forward the first, and the third the second, &c. And as before the Power increases progressively, in proportion to the Length of the Pier; so that by the Time the Current, which the Impetuosity of these Waves will promote, arrives at b. if in Time of Flood, it will there join with an increase the Power of the Current, e. and after all, it may be very probable, that other Waves may prove much more injurious to b. even than these. Let us, therefore, suppose

suppose the Wind blowing in a direct Line, as from i. to b. in Fig. 1. or from k. to g. in Fig. 2. and that a huge Wave advancing from k. to g. where the foaming Surge dashing against the Pier g. breaks by that powerful Obstruction, and then the Remains of it furiously recoils, as it were to recruit itself, and is joined with the next Wave, and makes another Attack upon g. then recoils again, and so on alternately.

Now please to observe, that these large Stones have (as I told you before) large Interstices or Vacancies between and among them; and the larger the Stones are, the larger are these Vacancies, and, like a French-Drain, will freely admit the Water to pass and repass. Consider then, when the Wave makes the Attack, how powerfully it forces its Way through every one of the Vacancies; and, in the Repulse, think what a most powerful Suction that Repulse will create, and how it will agitate the subterraneous Water backward and forward, by the quick Motions of these Waves; and you know that the main Drift and Operations of the Water naturally gravitate to the Bottom, and thereby break and rake it up incessantly. Now recollect the tumultuous Velocity of the Currents, f. and e. operating (if in Time of Flood) at the same Instant, and together with these Waves, hurrying all the loose Sand and disturbed Matters they are able to command along with them, until they have encreased that Curve-line, l. Then there will certainly be more of these large Stones thrown in; but the Wind and Current operating as before, they will soon sink that Bed of Sand to the Curve-line, m. which by this Time will begin to sap the Foundation of g. but that cannot be readily perceived, yet by a few Notes taken from the Sounding-board, it may easily be discovered, by observing the Line m. by Degrees sinking down to the Line n. which will still continue to advance farther and further under g. 'till at Length it will totally destroy and demolish it, unless it soon meets with a Rock or some hard Ground; and if a single curved Pier should happen thus to be erected, the Operations of the Tide and Wind, may perhaps, act nearly after the same Manner as just now described; so that I need not repeat them. Hence it is also evident, that the locking of

Headers and Stretchers together, no, nor all the Chain-bars, Cramps or Ties you can make use of in such a Pier-head, cannot preserve it after any considerable Part of the Bed whereon it stands is sapped and carried away from under it; which is a Truth so self evident, that I need not enlarge on it. Therefore, I recommend it to you to remember this, and to examine your Ground well before you attempt to lay a Foundation on it, especially at or near Low-water mark; but let us observe the Operations of Wind and Tide, on a Harbour inclosed with two Piers. See Fig. 3.

This Fig. 3. Exhibits the Plan of an Harbour inclosed with two Piers; and let us suppose, the Tide flowing from the South along the Shore, as from o. to G. and on approaching the Pier, is thereby repulsed and conducted round to q. and w. and in its Course, the small Dart at r. insinuates, that only a small Quantity of the Tide comes into the Harbour, just so much as is barely sufficient to keep the Water therein on a level with the ambient Water. The small Dart, t. shews the Current of the Ebb-tide, and if the Current, p. had Liberty to exert its Power, it would be repulsed by an Arch that could not yield to its greatest Forces; but there you see it joins with o. and continues its Course to q. and w. and the Current s. which seems to run directly to the Pier-head at t. is there also diverted and conducted to w. and q. but if we suppose the Flood tide coming from South West, as from u. it will then pass gently by the Heads of the two Piers, leaving a small Quantity to keep the Water on a level as before; and the whole Current of that Tide passes also on to w. and q. without even attempting any injury to either of the Heads. Besides these Advantages, a Harbour of this kind may probably afford an excellent shelter for small Vessels to the Northward of the Harbour, provided the direct Lines of these Piers extend any considerable Way into the Sea; whence I think it is evident, that such a Harbour, if effectually executed, and in a proper Situation, may be reasonably supposed to answer all the Purposes for which it was designed. I think, therefore, we may now endeavour on the Plan before us, to form and lay down principal Rules to design a Plan, for a Harbour of the largest Magnitude; but it may not be improper to take into our Observations,

vations, that if a Ship is making her Way from the fouthly Quarter, as from s. or u. to H. in a strong Flood-tide and violent Storm, it may be in great Danger of running foul upon the northerly Pier-head; and this you must consider, and take particular Care to guard against.

S E C T. IV.

Concerning the Construction of commodious Harbours of the largest Magnitude in the Sea; with Observations on the Operations of the Waves on the Pier-head. Fig. 4. And also, a concise Summary of the Principles on which these Propositions are founded.

BEFORE we can proceed in forming any Design of a large and commodious Harbour, inclosed with two Piers, as in Plate LX Fig. 3. I think it necessary to find out some one Dimension, from which we may derive a Probability of giving due Proportion to the whole: And it is evident, that here also we must be governed by the Depths of the high and low Water, which were already settled in Plate XLVII. Fig. 2. but the Depth of the Low-water is here particularly to be regarded, because deep Low-water will invite large Ships, and large Ships must have a large Space to make their Tack, &c. See Fig. 3. which is laid down by a Scale of 100 Fathoms, or 600 Feet to 1 Inch.

In this Fig. 3. you are to observe, that A. must be looked upon as your Model, by which you are to Proportion the whole; and here it is to represent the Depth of the dead Low-water, which was given at 20 Feet deep; therefore from the Point A. draw your perpendicular Line, and intersect it with the Line B. C. take the Depth A. and multiply it by 100, and that will give you 2000 Feet, for the Extent of the Line B. C. which you are to divide into ten equal Parts; then take five of those Parts, and set them down from the Point A. to H. and there draw the Line D. E. The Intersection gives you the Center, from whence describe the Semi-circle D. A. E. which is the outward curve Line of both these Piers. Then set in 72 Feet, or six Fathoms, for the inner,

or principal Coffers of the Pier, (which appeared by p. o. v. w. in Plate XLVII. Fig. 3.) at D. and E. and thence describe the inner Arch, and there will remain 1856 Feet for the Cord thereof; and upon these two Curve-lines at A. you are to form the Mouth of the Harbour, and Heads of the two Piers. See Fig. 4.

Fig. 4. (*Scale 40 Feet to 1 Inch*) Represents the principal Lines of a Section of one of those Heads, taken parallel to the Line A. H. and may convey an Idea of one of those Heads, standing upon the Coffers. Wherein note, that *a.* is the Bottom. *b.* Low-water. *c.* High-water. *d.* Center of the Pier-head. *e.* Platform, (about 64 Feet broad). And you see that all these Coffers together extend ten Cubes of A. (i. e. $10 \times 20 = 200$ Feet). The Letter *f.* is the center Line. *g. g.* Extent of the two inner or principal Coffers of the Pier-head, which may be environed with slender tongued and grooved Piles, to preserve the Lime-water. *g. b.* Breadth of the Guard-coffers, which are also to be environed with very stout Guard-piles, (the Tongues and Grooves to be put on with Spikes and stout Oak Pins, or made out of the Solid) to be drove down by an Engine, between the Sea-braces, as deep as possible, and then banked as before directed. *i.* Is the Lip of the Guard-coffer, and *k.* we shall suppose to be the Face or Front of the Pier-head. And having explained and considered all these Proportions, let us proceed to form the Mouth of the Harbour.

To find out the Centers of these Pier-heads: Divide the Line F. G. into eight equal Parts. Draw two Lines from the middlemost of these Parts, till they intersect the inner Arch-Line, which gives you the Centers required; which is equal in Distance to 500 Feet from Center to Center, or the fourth Part of F. G. (i. e. $A. = 20 \times 25 = 500 \times 4 = 2000$.) and each of these Centers are the same as *f.* in Fig. 4. Whence the Whole of the Coffers projects 100 Feet, or five Cubes of A. from *f.* to *b.* on each Hand, leaving fifteen Times A. or 300 Feet, for the Mouth of the Harbour between the Coffers. Thus you have seen that the Depths of the Water laid down in Fig. 2. Plate XLVII. has principally governed the whole of these Designs. The
Height

Height of the spring Tide, a. b. directed you to Proportion the Pier, and the Depth of the dead Low-water, a. A. enabled you to proportion the Extent of this Harbour; each of which, or any Part thereof, you may by the same Rules, either augment or diminish, according as various Circumstances may require.

Having observed the Operations, and considered the united Powers of Wind and Tide acting upon the Heads of strait and curved Piers; let us, in the next Place consider, that if a Ship is making her Way from s. or u. to H. in a strong Flood and violent Storm, she may perhaps, be in danger of running foul upon the opposite Pier-head.

To this Intent, let us seriously reflect on what has passed, and attentively consider, whether such a Work as this would be able to sustain such a violent Shock, as might happen from a large Vessel being precipitately forced against it.

I presume it is quite out of our Province, to determine precisely, the Power of any such Weight striking against either a direct or inclined Plain, such as I apprehend either the one or other of the Sides of these octagonal Coffers may fitly be compared to; but let us much rather endeavour in a plain clear Manner to consider, whether we may reasonably hope that this Work (supposing it to be properly executed) would be able to withstand such a powerful shock or not: And on this enquiry, we must first observe, (see Plate LX. Fig. 4.) that the Head of this Pier is so remote, that even the feeble point of a Bowsprit, would perhaps, scarcely reach to touch it, and therefore, the Coffers alone must sustain the shock. Now it is necessary also to observe, that these Coffers, taken together, from h. to h. be 200 Feet Diameter, and 23 Feet high, as hitherto determined; and here recollect the substantial Construction of the Coffers formerly laid down, how firmly they are braced, and made perfectly solid and compact with substantial and durable Materials; and that the Lip of the outward Hull, may perhaps, seem to be the feeblest and most exposed Part of it. Now, in order to reconsider this, turn back and look at Plate LV. You know how that was directed to be done, and this is to be done after the same Manner; and think, how firmly and substantially

stantially that Cut-stone Platform will brace and strengthen the Lip of that Coffe. Consult your own Reason, or that of any other judicious Person, on this plain Question, *viz.* Could any Ship by running foul on the Lip of those Coffers in any Direction, compress the Stones of this Platform any closer than they are here supposed to be laid? and if not; How can they yield or give Way to it? But taking it in another light: There is no doubt, but that even some Mariners will apprehend, that such a Coffe would be an insignificant Obstacle to a first rate Man of War under full Sail; but it may be also necessary for them to consider, that this Coffe (exclusive of the immense Weight of the Pier-head, and the lofty Beacon, or Light-house, that is to stand upon it) would weigh upwards of fifty thousand Tons, which we have found to be equal in Weight, to a solid Rock of *Portland* Stone of thirty-four Fathoms in Diameter, and near four Fathoms in Height; whence, perhaps, he or they may be able to form a clearer Judgment on the Effects of such a Rock, lying directly in the Road of such a Ship under full Sail; and on the Decision, you are to answer the Question proposed. We shall in the next Place, make some concise Observations on the Operations of the Waves on the Pier-head now before us. (Fig. 4.) The Depth from *a.* to *b.* being 20 Feet.

Let us consider a large Wave advancing from *b.* towards the supposed Pier-head, *k.* in its Way, the lower Part of it only will meet with, and be retarded by the Obstacle, *i.* the upper Part of it, will break and disperse on the Cut-stone Platform, *e.* and being thus weakened, when the remains of it strikes against *k.* it will make but a very feeble recoil during the Time of Low-water or young Flood. But let us suppose, a Wave advancing in a direct Line from *c.* to *k.* it will not meet any Obstacle till it arrives at *k.* where its full Power can only strike on one point, and disperse circularly, which will partly diminish its Power in recoiling, and the remaining Part of its recoiling Force, not meeting with any Obstacle, will be quite swallowed up in that Depth of Water. And also observe, that Waves advancing through the intermediate Space, between *b.* and *c.* both their attack and recoil will operate
entirely

entirely on *c.* which will be, as if it were, a Stage of Cut-stone of 64 Feet broad, prepared for them to act on.

The Motions and Celerity of the Waves, have been fully examined by many eminent Gentlemen; several of whom have on very just Grounds concluded, that the Motions of the Waves, even in a high Storm on the main Ocean, does not sensibly agitate the Water to any considerable Degree of Depth, from the Surface of the Cavities thereof; some say, not exceeding one Fathom deep: And if so, then generally speaking, the Water at *a.* will continue nearly in its natural tranquil State, and consequently, can neither disturb the Banking, nor sap the Foundation. Hence it is evident, that the utmost united Powers of Wind and Tide, can neither injure nor molest these Coffers, which is the principal Thing required.

But before I presume to introduce this most important Proposition into Practice, I think it adviseable to sum up, and to lay before you in one View, the Principles upon which I have founded these 12 Propositions, which I shall reduce to the following six concise Articles, in order to your forming a clear Conception of their Nature and Utility.

I. That sound hearty red Fir-timber, kept constantly in Water, will be extremely durable; and the Iron Cramps easily replaced if necessary.

II. That these small Stones, properly mixed with clean, sharp, sandy Gravel, *in Water*, exclusive of Lime, and being closely and securely confined together, will instantly become firm and compact, and consequently be a substantial Foundation for any Building whatever.

III. That the Stuffing hitherto recommended, will most assuredly turn to a real Petrification; and, that each of these Coffers will, in reasonable Time, contain one compact Substance, equal to the Strength and Durableness of a hard and solid Rock, which will be of the same shape of the clear of the Coffers in which they were moulded; and will be possessed of this remarkable Advantage, that the longer it stands, the harder it will grow.

IV. That

IV. That these Kinds of Foundations, in the weightiest Works, may (generally speaking) be effectually accomplished, with surprising Expedition, perhaps, by an ordinary Ship's Crew, and at a trifling Expence (in Comparison with other Methods) in any Country, throughout the greatest Part of the Universe; as there are, probably, but few Countries that do not afford such common Materials as are necessary for those Purposes.

V. That these Kinds of Coffers may be proportioned to any moderate Depth of Water; and that Coffers of fifty Feet high, may, in most respects, be as readily constructed, and the Work as effectually executed in a fresh Water, or in a moderate Tide River, as in any other lesser Depth, the Proportions being duly considered.

VI. That in any kind of Buildings that may hereby be erected in the Sea, it may also be observable, that if the Coffers were even made much slighter, yet, as they will be in a Manner quite beneath the Power of either Wind or Tide, they may be abundantly sufficient to oppose them both, and consequently, they can only operate on the Cut-stone, which they cannot injure. I hope, therefore, that I may safely conclude, that these are sure, quick and cheap Methods for compleating such Works, which are the three Things that I have endeavoured to accomplish. With this View, therefore, and on these Principles, I shall now venture to introduce this Proposition into practice, by laying before you, the Plan of a Harbour for the *Downs*, in *England*; which you may apply or vary, according as other particular Circumstances may require, either in that Place or elsewhere. And observe, that in this ensuing Design, in the Place of Fig. 2. Plate XLVIII. you may (by a large Scale) draw the Section, Fig. 4. Plate LX. with a Superstructure proportionable to it; and lay down the octagonal Plan thereof, so as to corroborate with the Plans of these curved Piers in Fig. 3. and also in Plate LXI. The Heads of which, I have been obliged, by the smallness of my Scale, to draw circular, and to omit all the Guard-Coffers; but I hope, all the other Parts and Proportions of these Methods, are so clear and distinctly laid down in them, and in the foregoing Plates, that I need not enlarge any further on them; and

and observe also, that the Height of the southerly Pier in this following Design, must perhaps, be of the same Dimensions as formerly laid down, Plate XLVIII. Fig. 1. But the Height of the North Pier, is entirely left to your own Discretion, with many other Circumstances which after strictly examining the Coast, you must determine on, as the Result of deliberate Consideration.

S E C T. V.

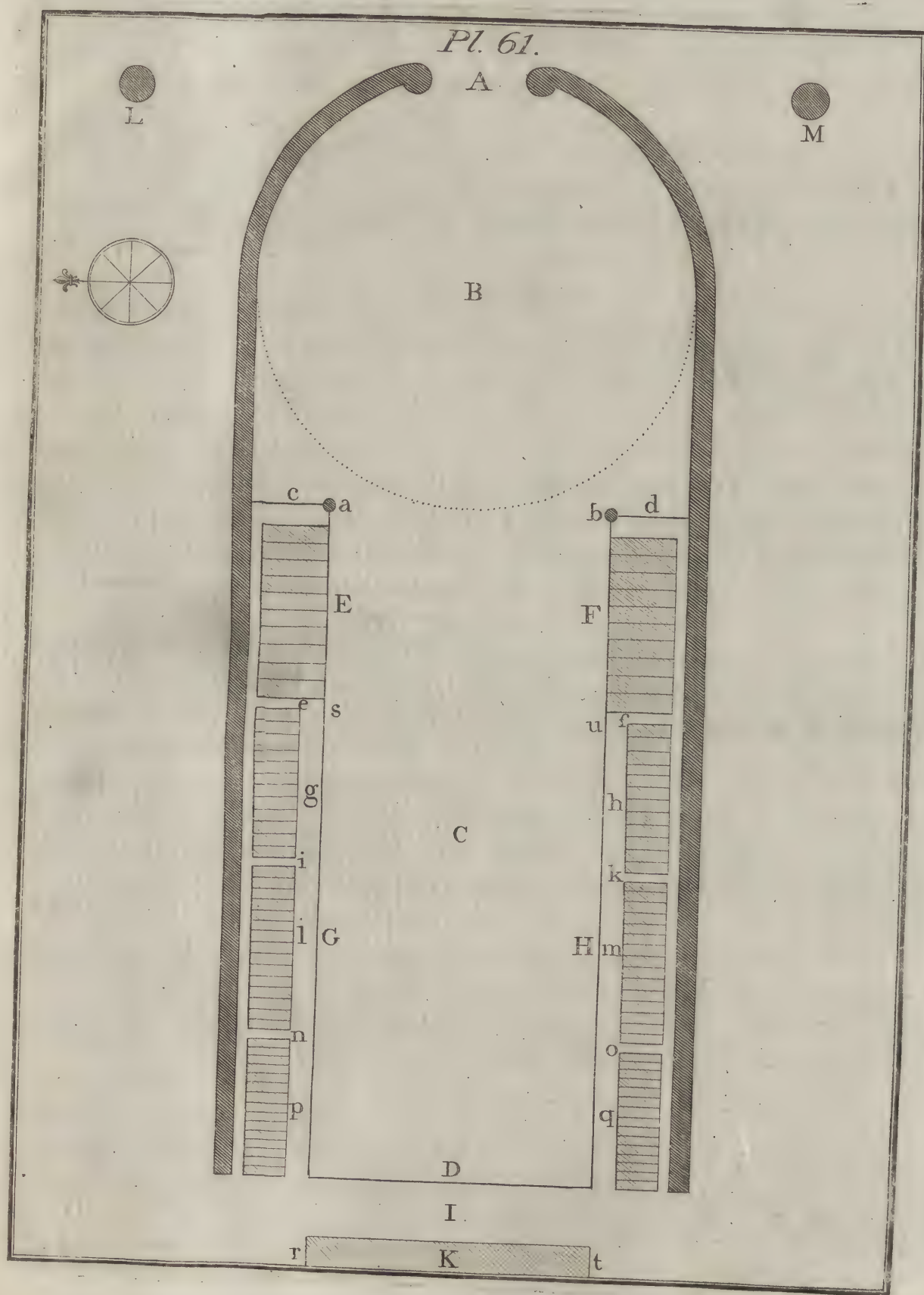
Concerning the Construction of a Harbour for the Downs, projecting to 20 Feet Low-water, the highest spring Tides supposed not to exceed 20 Feet more.

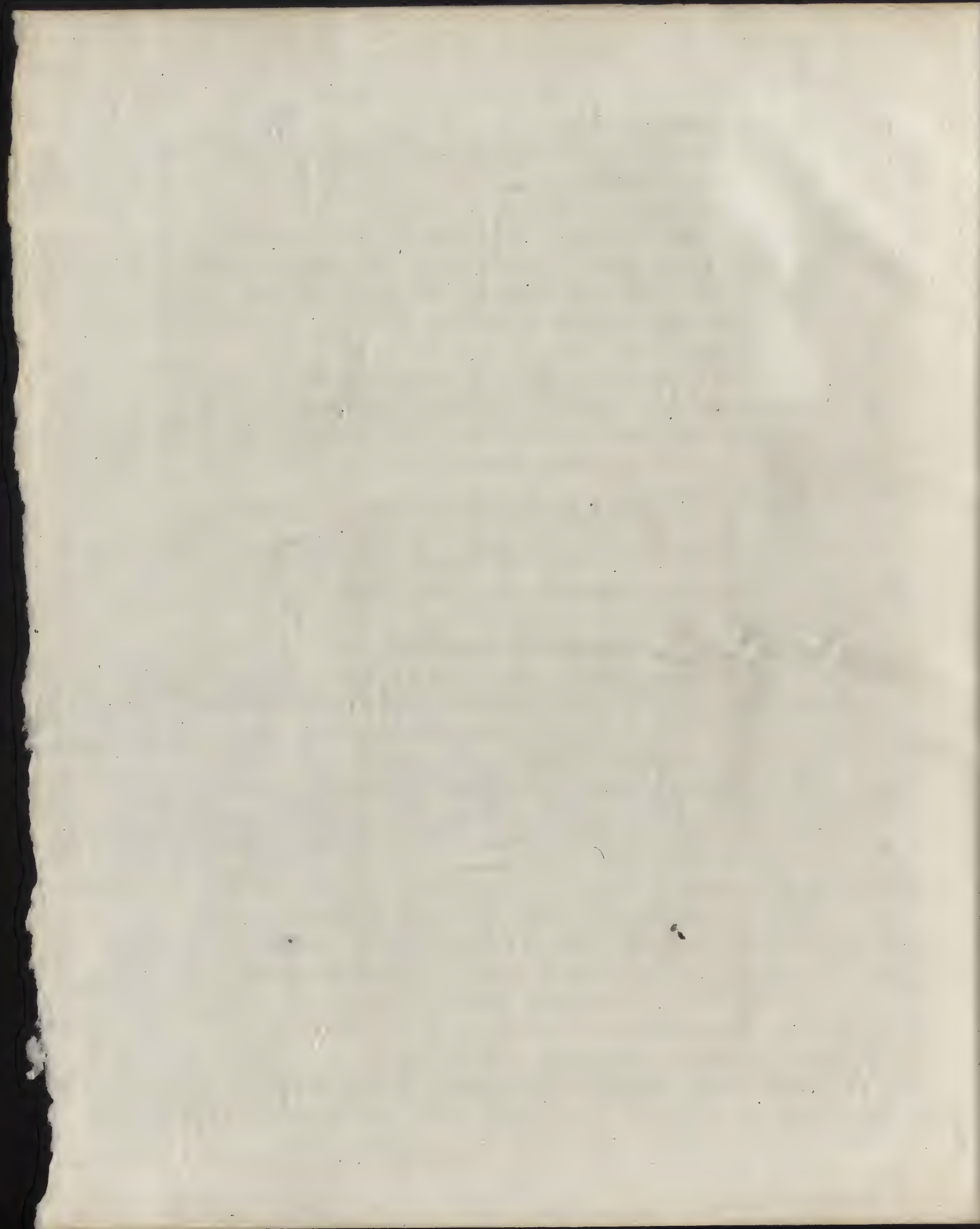
I HAVE told you that in June 1752, I went to *Ramsgate*, to consult Mr. *Ettridge* and Mr. *Preston*, who were pleased to favour me with a Copy of the Plan of their Harbour. During my Stay there with them, and the Captain that brought them the *Portland Stone*, great Part of our Conversation turned on different Opinions, concerning a Harbour for the *Downs*; and as I then had an Opportunity of hearing many pertinent Remarks on the Subject, to satisfy my Curiosity, I took a cursory View of the Shore thence to *Dover*; and I afterwards collected several other Plans, Charts and other Remarks; and on my return Home, employed one of my Clerks to copy them, and reduce the whole into a concise little Book, which now lies before me, and which I have many Times studied with the greatest Assiduity, in hopes of accomplishing what I most earnestly desired: And at Length, I completed what I am also now about to lay before you, as the ultimate End of these Propositions; but observe, that all the Materials which I collected, were not by any Means sufficient to determine me, especially as to the properest Situation for it, because I had not any Borings, or correct Soundings of high and low Water; I must therefore, leave these Matters at your Door, but shall give you a few necessary Hints concerning the Situation in the Sequel.

PLATE LXI. (*Scale 100 Fathoms or 600 Feet to 1 Inch.*)

This Plate exhibits the Plan of the Harbour, which I have designed according to the general Rules of Proportion, laid down in Plate LX. Fig. 3 and 4. And herein note, that A. is the Mouth in twenty Feet deep of dead Low-water. B. The Bason for the largest Ships, extending 1856 Feet, or about one third of an *English* Mile, in the clear of the principal Coffers as before, which in this, or the like Cases, you may dispose of after the following Manner: Out of this 1856 Feet, take the odd 56 Feet, and divide them into two equal Parts, and give one of those Parts to enlarge the Thoroughfare at the Rear of the Lots; then divide the 1800 Feet into 18 equal Parts, three of which (being 300 Feet) are to be the Depth of the Lots on each Side, and the remaining 1200 Feet are to be the Breadth of C. which is to be the Port or Haven for trading Vessels, (which is just the Breadth of the River *Thames* at *Westminster-bridge*). D. Is the Port-head at the Custom-house Quay, which must be six Feet deep at the dead low Water. a. and b. Are two small Beacons. c. and d. Two Quays of 328 Feet long, and 70 Feet broad each. E. and F. are twenty Lots for Docks, each Lot seventy Feet Front, and 300 Feet deep. Then divide the 300 Feet into three equal Parts, of which you leave two on each Side for the Depth of these Lots, and one on each Side for G. and H. which represents the two principal Quays, each of which will be 1770 Feet long, and 100 Feet broad. Wherein also note, that e. and f. are Thoroughfares to the Rear, and 50 Feet broad each. g. and h. Twenty-four Lots for his Majesty's Magazines, being 50 Feet Front, and 200 Feet deep each. i. and k. Thoroughfares of 40 Feet broad. l. and m. Thirty Lots of 40 Feet Front, for public Stores and Weigh-houses. n. and o. Thoroughfares of 30 Feet broad. p. and q. Thirty Lots for principal Merchants Companies, to store their Imports and Exports, till further Orders. I. A yard, wherein you are to make the Coffers, &c. and afterwards it is to be the Custom-house Quay, extending 1200 Feet long, and 300 Feet broad.

Pl. 61.





broad. K. Public Stores and Weigh-houses on the Ground-floor, and Custom-house and Exchange on the Second-floor, &c.

I shall now give you a few short Hints concerning your making a proper choice for the Situation of this Harbour. I told you above, that I had only taken a cursory View of the Coast, and therefore, cannot be expected to fix upon the Scite; but from such poor remarks, as I have been enabled to make or procure, for many reasons I apprehend, that a little to the Northward of *Deal*, or somewhere about *Walmer*, would be very proper for the purpose. However, observe, that I do not pretend to determine this Point, or to enter into any minute Circumstances concerning it; but I shall just briefly recommend two principal Guides to conduct you to a proper Situation.

I. First set out in a direct Line from the most promising Place on the Shore, till you come to six Feet deep at dead Low-water, and that determines the Scite of letter D. Then proceed in the same Direction, till you come into twenty Feet deep of the like Water, which gives you letter A. and herein observe, that the Extent of A. from D. is just equal to 4396 Feet in the clear; but I presume, that it would be infinitely better, if A. and D. were double nay, treble that distance, from each other, for this very important Reason, because the Merchants of *London* would be better accommodated, with a convenient Number of Store-houses, to preserve both their foreign and domestic Commodities, according as their different Occasions might require, without giving the least delay to their Ships or Men; by which Means, this Port would not only prove a Place of Safety, but among numerous other Advantages, it would answer extremely well as a Mart or noted Place to carry on Trade with the whole World. For these, and many other weighty Reasons, I advise you not to be afraid of making the Distance too extensive between A. and D. for when the Basin B. is finished, the Expence of carrying the Piers home to the Shore, will be very trifling in Comparison with the yearly Value any eminent Merchant would put upon one of those Lots.

II. I shall now in the second Place, point out another Guide to conduct you to a proper Situation for this Port, which you will find

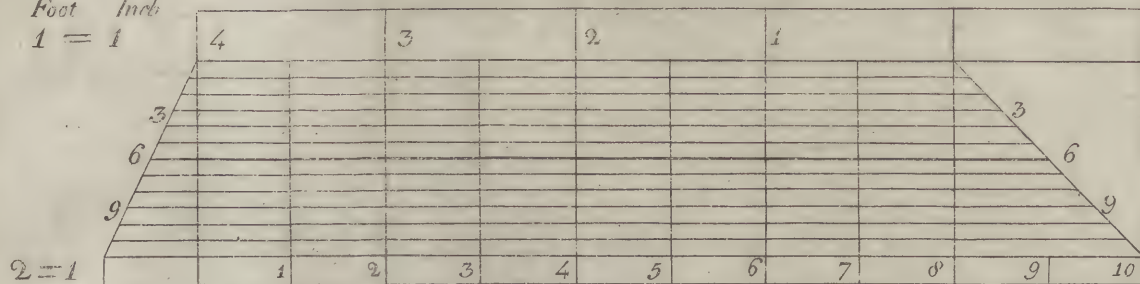
to be of such vast Consequence, that neither Time nor cost ought to be spared to find out and procure it, if possible; and that is a full command of pure fresh Water.

I cannot certainly say, whether or no the River *Stower* could be taken up, or even a Part of it, conveyed to some convenient Place for this Purpose; but I have Reason to believe that it may, or perhaps, some other Rivulet may answer better; but be that as it will, I do most earnestly advise you, to procure plenty of pure fresh Water, sufficient to keep up in the driest Season, a spacious Reservoir, contiguous to the Rear of K. or somewhere to the Westward of the Port; and from this Reservoir to carry two Conduits, one through the Middle of each Quay-wall, as it were from r. to s. and from t. to u. they must be at the least 4 Feet wide, and 7 Feet high in the clear, to be built with well chiseled Stone, in staunch Cistern Work, as formerly directed, each of these Conduits must have a Sluice at the Reservoir, and another near to the Extremity of each Quay as at s. and u. into which common Sucking-pumps must be set at about every Ship's Length, in Proportion to the several Depths of Water, with proper Air-pipes, &c. This I repeat, will be of such vast use, that no Money should be spared to procure it. I shall give you but one Instance on the whole: Suppose a Sloop or Tender, should come to this Port in great haste for Ammunition, or Provision, she might sail up to the Magazines and be instantly loaded; and yet, at the same Time, by the Labour of three or four Men, this pure fresh Water can be pumped, and by Leather-tubes conveyed, even into the Water Hogsheds in the Holds; and with all this she might set out again, without paying any regard to the Tide, or losing the least Time imaginable by taking in her loading.

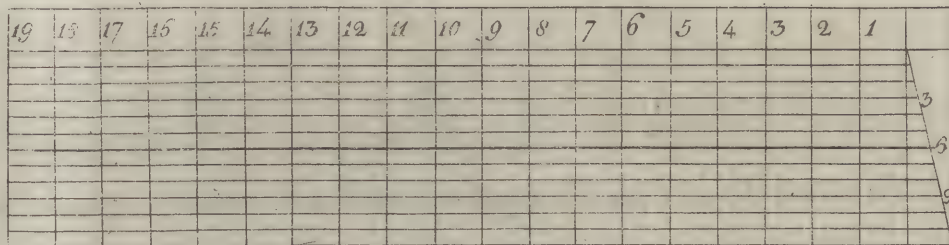
I do not in the least doubt, but that there will be some political Objections made to this Design; because perhaps, this Port might at some Times contain immense Value of *British* Property, and in Time of War be liable to Hostilities. In order to obviate that Objection, you may on these Principles and Methods erect two substantial Forts at L. and M. provided you find those two Scites
of

Pl. 62.

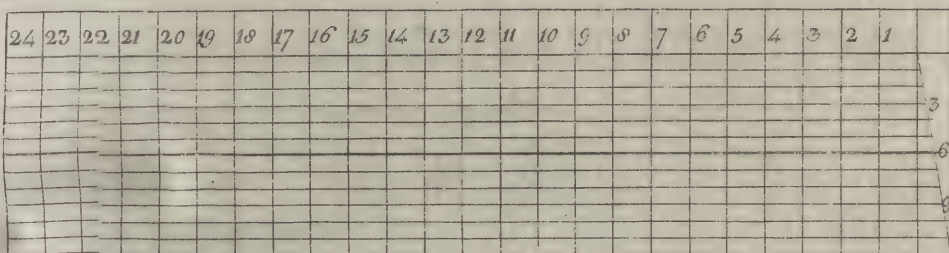
Foot Inch
1 = 1



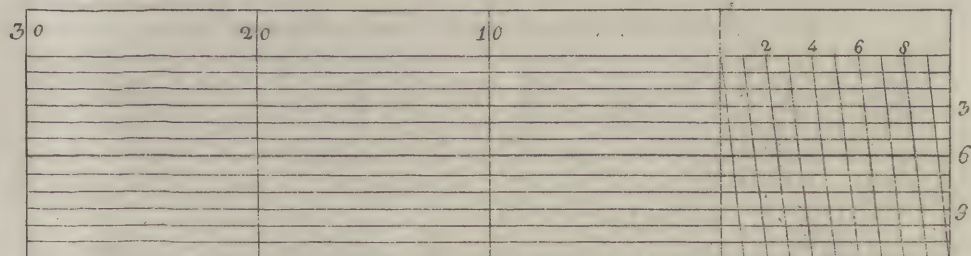
4 = 1



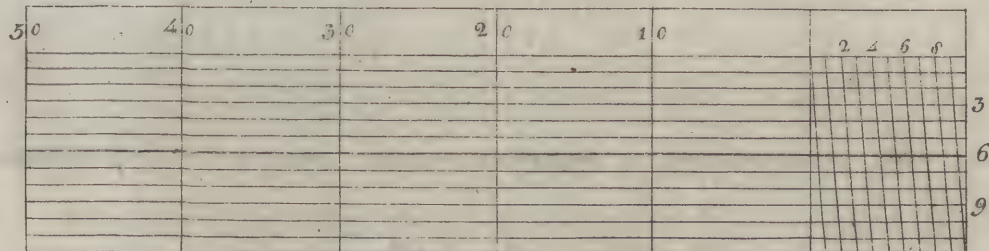
5 = 1



8 = 1

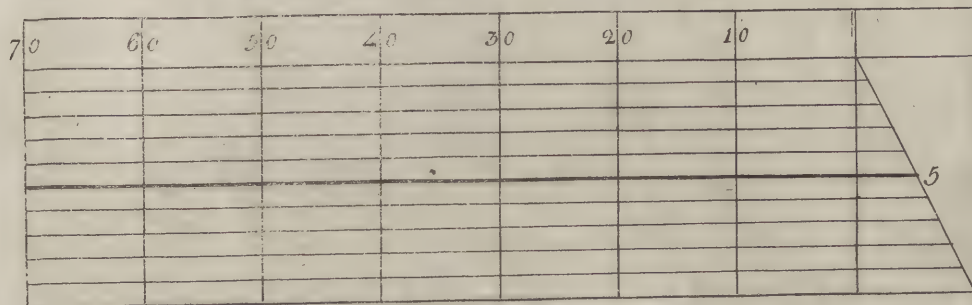


12 = 1

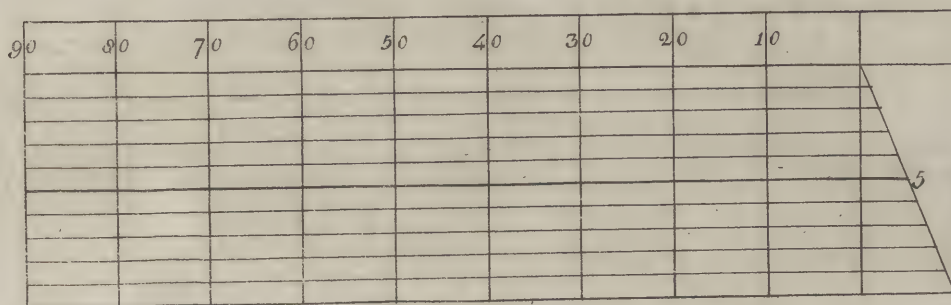


Pl. 63.

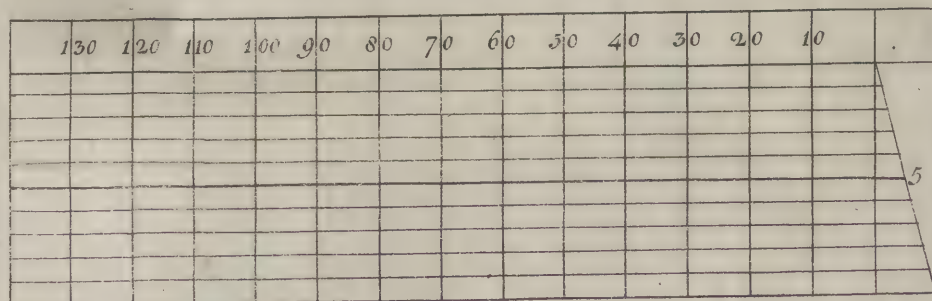
$F^t I$
 $16 = 1$



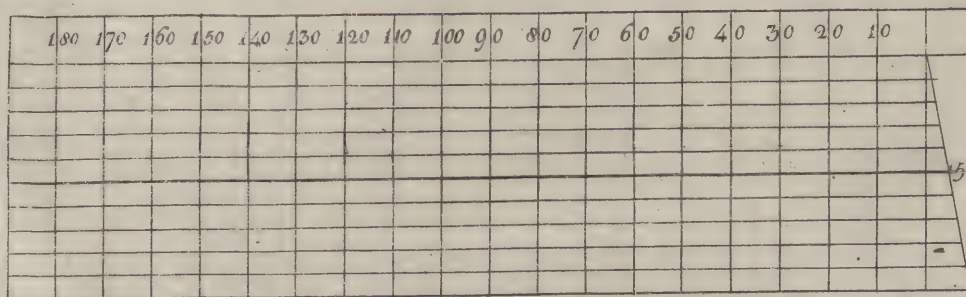
$20 = 1$

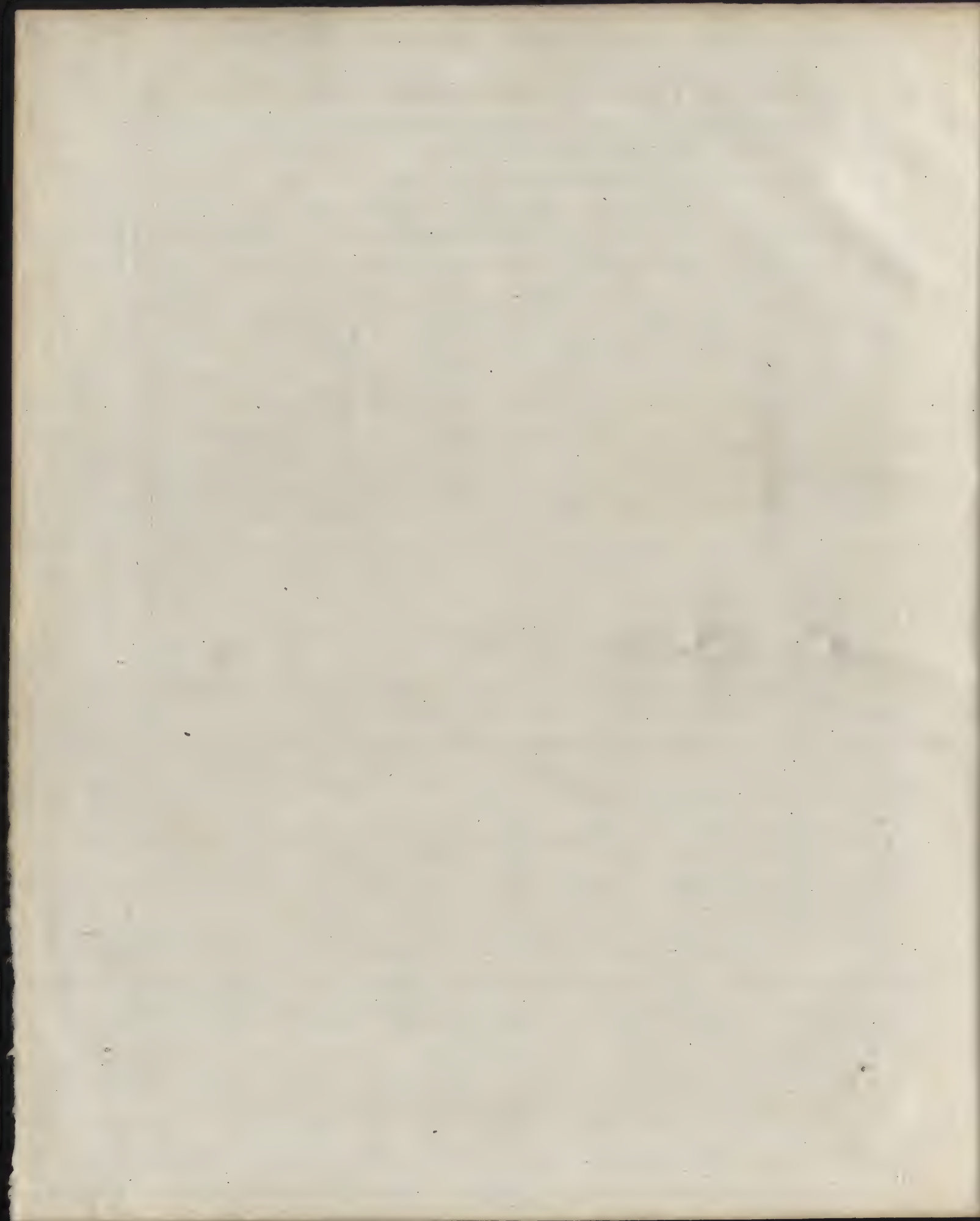


$30 = 1$



$40 = 1$





of moderate Depth, by which I presume that this Port may be safely protected, and the Channel effectually guarded thereby.

Plates 62 and 63, furnish you with the Scales, by which all the foregoing Draughts were minutely laid down, except fig. 3, in Plate 60 and Plate 61; which are to be taken off by a Scale of 600 Feet to 1 Inch, as before mentioned; and by comparing the same with Plate 48, you may make a Scale to answer any other Depth of Water, but not to exceed 20 Feet deep, and adjust all the Proportions according to Plate 47, Page 133. And notwithstanding this Design is of so large a Magnitude, yet it must be admitted, that it will not by any Means be disproportionable to the *British* Empire, especially, as it may be a Mart to all the Mercantile World, in case there can be no other Place found elsewhere that will be more convenient for that Purpose, which we may consider among other Matters in the third Part hereof.

END of PART the SECOND.

P A R T III.

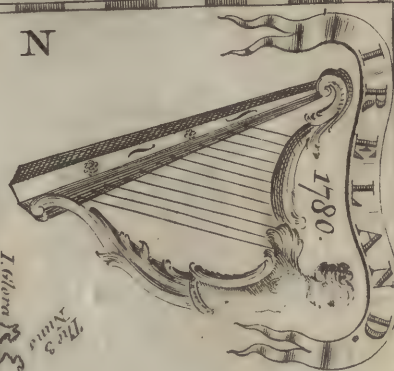
Concerning a Plan for encreasing the commercial and landed Interest of *Ireland*; and briefly demonstrating that not only *Great-Britain*, but the whole *British* Empire may gain considerable Advantages thereby.

THAT it is the Interest of *England*, that *Ireland* should grow and flourish in Trade and Wealth is manifest: Yet it hath been a grievous Misfortune to us to have it otherways apprehended, not only by many of the Manufacturers, but even the Statesmen of *England*; which must have proceeded from their not understanding the Affairs of this Country, and not discerning its true Interest. For it is in Politics as in the human Body, if any malignant Humour proves predominant in any of the Members, the Disease becomes general, and in Time may affect the whole Body: And I think that any Man of common Understanding may account for this Mistake, that recollects the First of July 1690. Were not the very Vitals of their Ancestors and ours promiscuously mingled together on that glorious Day?--- Are not the People of both Kingdoms connected and united together by firm Ties of Affinity and Friendship? Do not wonder then that the general Addresses of our Patriot Parliament, that echoed the Voice of the whole Nation, reach at length to the Ears of His Majesty, who, ever mindful of the good of his Subjects in general, and balancing the Scale of Justice, has from his Throne pointed out the Means of making us a happy and opulent People, by establishing us in a Free Trade, which memorable Event happened in the first Week of *March* 1780,
communicated

ATLANTIC OCEAN

Pl. 64.

1780.



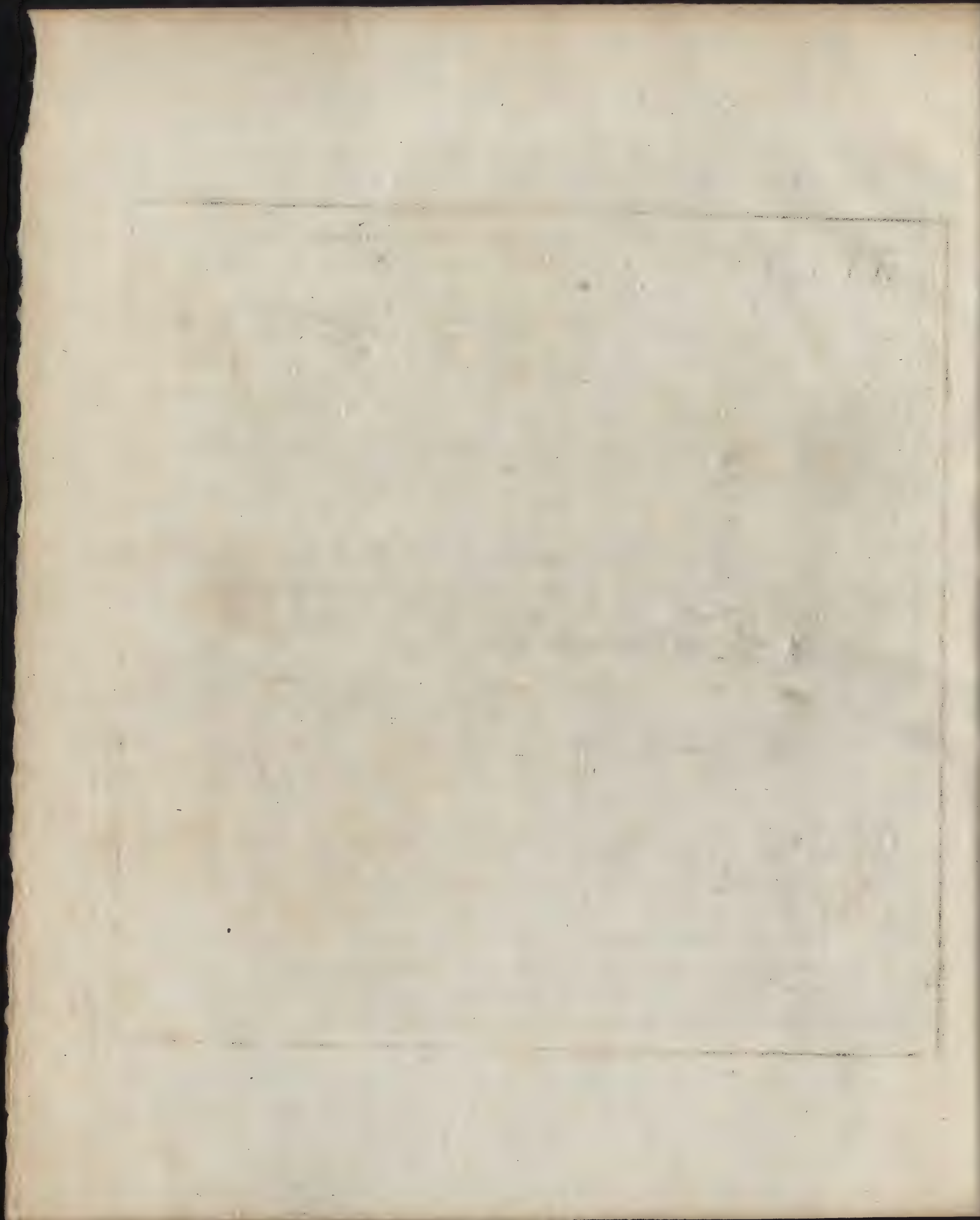
Minutes of time W. from London.

XL

XXX

XX

Long. W. from London.



communicated to the Public through the Channels of all the News-papers in this Kingdom to the following Effect :

“ Act of the British Parliament, for granting *Ireland* a FREE
“ TRADE.”

“ Anno regni Georgii III. Regis magnæ Britannix, Francix,
“ et Hibernix Vicefimo.

“ At the Parliament begun and held in *Westminster* the
“ Twenty-ninth Day of *November* A. D. 1774, in the 15th
“ Year of our Sovereign Lord *George* the Third by the Grace
“ of God, of *Great-Britain, France, and Ireland* King, Defender
“ of the Faith, &c. And from thence continued by several
“ Prorogations to the 25th Day of *November* 1779, being the
“ fixth Session of the fourteenth Parliament of *Great-Britain*.
“ Chap. 10th.

“ An Act to allow the Trade between *Ireland* and the *British*
“ Colonies and Plantations in *America* and the *West Indies*, and
“ the *British* Settlements on the Coast of *Africa*, to be carried
“ on in like Manner, as it is now carried on between *Great-*
“ *Britain*, and the said Colonies and Settlements.”

This Act is very long, and it is not by any Means necessary for me to swell up this little Treatise with it : But however, to prevent Mistakes, I shall insert the concluding Clause ; viz.

“ Providing always, and it is hereby further enacted by the
“ Authority aforesaid, that this Act shall not extend or be con-
“ strued to extend, to allow any Person or Persons to trade to,
“ from, or in any Colony or Plantation in *America* during such
“ Time, and in such Manner as the Trade or Intercourse of
“ *Great-Britain*, with such Colony or Plantation is or shall be
“ prohibited or restrained by any Act or Acts of Parliament made,
“ or hereafter to be made in this Kingdom. But whenever
“ Trade and Intercourse shall be permitted between *Great-Britain*
“ and such Colony or Colonies, the same Trade and Intercourse
“ shall in like Manner be permitted and allowed between *Ireland*
“ and said Colony or Colonies.”

C H A P. XVIII. S E C T. I.

Concerning the Purport or true Meaning of the Words FREE TRADE, with some Preparatives thereto.

LET us now endeavour to ascertain the true Meaning of these two Words; for till that is determined, it cannot be known with Certainty whether my Designs are properly adapted to those Purposes or not.—The Words FREE TRADE have been a copious Topic for Argument to innumerable Gentlemen and others these Fifty Years. They have also been a Bone of Contention between the Trading People of the two Kingdoms. During that Time there have been some People industriously employed in sowing Seeds of Division between them and us: And the more firmly did those Kinds of Seeds take Root, by those Persons having strong Matters of Fact to ground their Arguments upon, I shall only mention one of them, *i. e.* A Brave and Loyal People, labouring even under the deplorable Want of the ordinary Necessaries of Life. For Instance, this Moment there are actually between 900 and 1000 of poor wretched People pent up together in one House in *Chammel-row*, and kept from expiring in the Streets by the charitable Contributions of the generous Public, which perhaps cannot be paralleled in Europe.—But let us return to our Subject, and use our best Endeavours to contrive Ways and Means to remove all these shocking Kinds of Grievances in future; by the Free Trade we are blessed with, and which was long ardently wished for by all Kinds of People in the Kingdom.

Now, if this whole Affair was left to me, I think I would only desire six plain *English* Words to be added to these two Words to support my Plan, for the Redress of all these Grievances, as laid down and pointed out in the following Pages. One of these Words I would wish to be placed between the two Words, *viz.* The Word, TO, and then the Sense of them would be FREE TO TRADE, and which might, in some Degree,

Degree, answer my Purpose: But, to prevent Mistakes, let it be supposed, that the whole Sentence ran thus: Any Man is free to trade in *Ireland*; or that all Men are free to trade (or to follow their own Occupations) in *Ireland*. Then consequently it is incumbent upon us to discover how it comes to pass, that *Ireland* should be distinguished from the rest of the World in so high a Degree, as to have such a peculiar Appellation bestowed upon it.

In order to this Enquiry let us first examine the Map of the World, and there you will see how this poor little Spot is situated; observe how it stands free and open to trade with the whole Mercantile World. View it in the Map of *Europe*, and observe how commodiously it is situated for Trade in this Quarter of the World; but particularly, please to strictly observe and minutely consider Plate 64. And there behold an Island, as if designed by Nature for Commerce; an Island, that has spacious and commodious Harbours quite round the Kingdom, with proper Depths of Water for Ships of the largest Magnitude, and withal an Island of great Extent; blessed with every Comfort in Life, and therefore fit to relieve and refresh the poor wearied and emaciated Mariner; and also naturally abounding with all the Necessaries of Life.

Now if these Things are attentively observed, and strict Enquiry made through all *Europe*, where can you find any one Spot so commodiously laid out for Trade and Commerce? And if none such can be found, does it not seem, as if the bountiful Hand of Nature had liberally bestowed those and numerous other Blessings upon it, to make our King and Country great and happy?

Let us therefore now proceed, and enquire how all these peculiar Advantages are to be applied; and surely it must naturally occur, as it evidently appears, that it was designed for a MART, or a notable Place of Commerce, for the trading Part of Mankind to meet and to carry on a *Free Trade* with each other: And hence I presume that the Improvements, which are necessary to be made, to answer these salutary Purposes, may be dis-

tinguished by these two Appellations, *viz.* the exterior and the interior Improvements. The outward Parts of this Kingdom, I believe, remain to this Day nearly in the same rude State that Nature left them in; and to fit them for the great and important Purposes of universal Commerce, there must be Tongues, Quays, Docks, Wharfs, and perhaps some Piers, Beacons, Light-houses, and other Improvements, to make safe and convenient Ports, &c.

The interior Parts in many Places also continue, in the same rude State, and call loudly for Improvement.—In order to which our gracious King, and his Ancestors, have already begun a most noble Improvement, *i. e.* the Inland Navigation, which in Time will join the Navigation of our spacious Loughs and Rivers together, and convey all our Exports to the Ocean. Our Roads are to be made much more spacious and convenient, which will require Bridges of various Dimensions;—a great Variety of Designs for these and many other Purposes have been before given.

The first Things therefore that are to be done, should be to get very correct Surveys of the Coast quite round the Shore, the Soundings to be correctly taken at least to the Distance of one League into the Sea, and also the Soundings within all the Harbours and Navigable Rivers, so far as may be contained within the Plans of the respective Ports, and from thence so far as they are navigable up into the Country, without meeting with any Shoals, till you come to four Feet deep at low Water. And they are to be inserted in the respective Maps of the Counties through which they run or are adjoined. And the Maps of the Ports should be drawn for and bound up in large Quartos, so that not only the Committees or other acting Gentlemen, but the Public in general may have an Opportunity of considering and proposing such Plans or Schemes as they think proper for their Perusal.

There have been Surveys already made of several of the Counties: The Remainder of them ought to be directly put in Hand, and when they are compleated they all ought to be carefully and minutely laid down in a four Sheet Map of imperial or elephant

elephant Paper, on which every Gentleman's Estate ought to be carefully pricked out, so that the Parliament, or any of the local Committees, and the Public, may clearly see where any of the principal Improvements are to be made; on all which I intend to treat a little more largely in the Sequel: And in the mean Time I apprehend that the Public in general should be apprized, that these Matters are in Agitation, and that there should be particular and friendly Invitations given to the Merchants and Manufacturers of *Great-Britain* to traffic and trade with us. And there are also numerous other Things to be done and considered, previous to this great Undertaking, which must be postponed at present. But before I enter on any of the principal Matters, in my Plan for the interior Improvements, I must beg Leave to give a short Account of a little Tour I made through Part of this Kingdom on my own Business, with some Remarks I made in it.

On the 13th Day of *August*, 1739, I set out from *Dublin*, and after much riding, came to Sir *John Bingham's*, in *Castlebar*, thence to *Newbrook*, and from thence I set out from Mr. *Bowen's* on the 26th, at Six o'Clock in the Morning fasting. My Route was for *French Park* in the County of *Roscommon*, which, as I was told, was computed at fifteen Miles, and that I was to go through *Breeze* and *Mourneen*, which was one Reason of my not taking any Breakfast, as I thought to take it at the former. But, behold, the Inn was a little Hut made with Sods, with a Hole on each Side of the Door, of about a Foot square, by Way of Windows, which was generally stopped with Straw in cold Weather, and another Hole left open in the Thatch for the Smoak, and a Piece of a Turf hung by a String on a Bit of a Stick by Way of a Sign, and the only Improvement I saw about it was two old Whitethorn Trees, and before me I could not see any one individual Thing but Heath. However, I pushed on till I came to *Mourneen*, and that was just of the same Kind and Condition of the former, where nothing was to be had but Whiskey and Tobacco, and the like dismal and extensive Prospect was all around me. But at length, having grown extremely hungry, to my

my great Joy I espied a pretty little white House, which I ardently wished might happen in my Way ; so it nearly did, and I rode up to the Door, and asked a Servant Maid that stood there, if it was a public House, and she answered, no ; but I heard a Voice prompting her, and she asked if it was a public House that I sought for. I answered her I wanted to breakfast. With that a very genteel-looking Gentlewoman advanced, and desired me to alight, which you may be certain I was not long in doing. In short, I think a more hospitable Reception I never experienced.—Her Name was *O'Mealy*, and she was a Descendant of the Family of *Grana-Veal*.

I soon set off again, and about 3 o'Clock happened on such another Inn as those two I have described. But I shall not trouble my Readers with my Repast, yet I sincerely pitied the deplorable State of that Family.

I pushed on again with the same dreary Prospect around me, not meeting through the whole Way any Thing that could be called a Road ; indeed, in many Places I could hardly discover even a beaten Path, but what was almost covered with Heath, nor any Thing else to be seen quite round as far as my Eyes could reach ; and yet it could not be called a Mountain, but I believe a great Part of it was boggy, because it all seemed tolerably level. Now whether I missed the right Road through this Heath or not I cannot affirm, but at length I found myself quite lost, and could not find any Thing like the Traces of a Road ; and as Night approached, I concluded, that I must take my Rest by lying down among the Heath with my Horse tied to my Leg. But alas ! I could meet with nothing through the whole Day that was fit to nourish him, and so I wandered about on Horseback, till at length I had the Comfort of Moon-light, and fortunately for me heard a Man whistling. I made toward him, and found he was herding a little Field of Oats then in Stocks, and I hired him to guide me to *French Park*, to which I did not arrive till after Ten o'Clock : And I can safely affirm, that, to the best of my Knowledge, I did not see above six Houses, such as I have described, nor above eight Men and Women, and perhaps,

haps, not above half a Score of any Kind of four-footed Beasts ; and as I was exceedingly well mounted, I can safely conclude, that I certainly must have travelled upwards of forty or forty-five Miles that Day.

Having now laid the Contour of this most dreary Landskip before my Readers, I shall only draw one short Inference from the Whole, on a Supposition, that the nine Hundred of miserable aged People, now pent up together in the Poor-house in *Channel-row*, as above mentioned, had been then settled in this spacious Tract of Ground, and even two or three Knit Stocking Manufactories set up among them, what a populous and flourishing Colony might that have been now ! What an Addition might it have produced to the King's Revenue ! What a vast Number of Soldiers and Sailors might it have afforded for his Majesty's Service ! But what an additional Fortune would it by this Time have produced to the Proprietor or Proprietors of that extensive Country !—And even now, would a Company of Gentlemen join, and either purchase or take renewable Leases of those and numerous other such waste Places, throughout this Kingdom, and establish thereon Colonies of industrious People to carry on Manufactories and Trades of different Kinds ; would not this tend to the Emolument of the Nation ? And hence I also prove, that it is absolutely necessary for the Public to make spacious Roads through all these Sorts of Places in numerous Parts of this Kingdom, many of which I have seen, even in this Tour, having rode through fourteen Counties within the Compass of three Weeks. I shall not trouble you any farther with this Affair, but leave it to your own Reflection, and return to examine in what Sense these two Words, FREE TRADE, are to be taken with respect to our Exports and Imports, adapted to the Intentions of our present Plan.

S E C T. II.

Shewing in what Sense the Words FREE TRADE are to be taken, with respect to our Exports and Imports, and how they are to be adapted to our present Plan.

I BELIEVE the Merchants of this Kingdom are Gentlemen of as great Understanding and Veracity as in any other Country whatever: Therefore, with great Diffidence, I presume to lay my Plan before them, as it is a Matter wherein they are so nearly interested; and in case it does not coincide with their own Sentiments, with regard to Imports and Exports, they may reject the Whole, or any Part, as they may find consistent with their own and the public Good.

I have already demonstrated, that this Kingdom seems, as if it was, by Nature, designed for a Market-place for the mercantile World; and by our Scheme to be appropriated to that Purpose, to wit, *That all Men are free to trade in Ireland*, and that is, in this Case, to carry on a commercial Trade to its utmost Extent; and therefore I humbly apprehend, that it is evidently incumbent on our Merchants to ingratiate themselves into the Esteem of all the *British* Merchants, Companies, and others, at Home and Abroad; and in particular to shew and explain the many and great Advantages that must certainly arise from their entering into such an extensive Trade with our Merchants, by sending their Commodities to our Market, and assuring them, that they will either buy, sell, change, or exchange whatever they send with the utmost Expedition, according to their Advice: That they will not only be stored at all Times with our own native Commodities, but also with all Sorts of *British* Merchandize, as any Parts of these Kingdoms produce, as well as those of numerous other Nations also.—That they will act for them as Factors on Commission; or if they send their own Factors, they will accommodate them with Store-houses, and all other

Conveniencies

Conveniencies that may in any Ways be necessary for them, on reasonable Terms.

Hence it is evident, 1st, That our Merchants (from what has been and will be hereafter said) can carry on the Business of Imports and Exports at their own Doors. 2d, That all the Merchants in this Kingdom ought to associate, and hold a general Meeting in the *Royal Exchange*; and there consider of all such Matters and Things as may be necessary to, or consistent with, a *Free Trade*. But particularly, and without Delay, to observe what is pointed out in the latter End of page 162 and in page 163, &c. concerning the Maps of the Shores, &c. for no Advances can be made till all these Things are considered, and proper Improvements made in the Ports, fit for Ships of various Burdens, which must load and unload without grounding. And remember, that I recommend it to your best Attention to observe what I have mentioned in the latter End of page 155, &c. Article 2d. For if all your Tongues, Quays, and Wharfs are made after the Methods there mentioned, they will be strong Inducements to the *British* Merchants and others to frequent your Ports, and consequently render them very popular, and also be the Means of bringing many Foreigners to reside among us, on Account of our *Free Trade*. But all such must know, that though all Men are free to follow their own Trades and Occupations, yet no Man can be permitted even to live among us, that is not a true and loyal Subject to his present Majesty King *George* the Third and his Successors. He must demean himself peaceably and honestly; he must pay *Scot* and *Lot*, as from Time to Time may be customary among us; and also his Proportion of the King's Revenues and Duties, as have been usually paid toward the Support of the Government, or according as the same may be hereafter settled and adjusted by our Legislature. All which is consistent with Reason and the Laws of all civilized Nations; And therefore any Man that doth not demean himself according to our Laws and Customs, cannot expect to live among the good peaceable People of *Ireland*. I shall now proceed and lay before

fore you a concise Sketch of some of the interior Improvements consistent with a *Free Trade*.

S E C T. III.

On Roads, Fairs, Markets, &c.

BEFORE I enter on the first of these Subjects, (to prevent Repetitions) I recommend it to you to refresh your Memory by turning back to page 118, Chap. 16th, Sect. 1st. and 2d. for there you will find Methods to accomplish much more difficult Works than any that may fall to your Lot. However, if even a considerable Expence should be necessary in these Cases, it will be better for the Public to bear it, and have Things done well, than to do Things in a bungling Manner at a trivial Expence. But of this you will be the best Judge hereafter.

The Making of good Roads is reckoned among the principal Improvements in all Countries. The landed Interest did not begin to rise till we began to make Turnpike Roads, and whilst ever we continue to improve the one, we shall raise the Interest of the other. Many of our new Roads are tolerable, but there is one general Fault in them all, *i. e.* their being so narrow, and so crooked, and perhaps, much more so than in many other Countries. The Reason is obvious. This Kingdom, in ancient Times, abounded with Woods, Bogs and Loughs. The then poor Inhabitants, in a Manner, groped their Way through them, not minding whether the Road they took was long or short, provided they could any Ways accomplish their Journey; and the Paths they then trod out, being from Time to Time cleared and improved, at length they became more populous; but till within this Century, there were but a few of the Inhabitants that discerned that Inconveniency, and they still continued to follow the old beaten Path which served their Fore-fathers. But now as we have got a *Free Trade*, let us use our best Endeavours to improve our Roads, so as to make them capable of answering
their

their natural Purposes, and promoting the Extension and Good of Trade ; especially, as both the commercial and landed Interest may be greatly benefited thereby. And to that End I humbly conceive, that the most advantageous Improvement that this Kingdom is capable of, will be to make a spacious and an elegant Turnpike Road from the City of *Londonderry* to that of *Cork*, as nearly on a Level, and in as direct a Line as can conveniently be accomplished (See the before mentioned Plate 64.)

This grand Road you see will almost divide the Kingdom into two equal Parts from North to South ; the first Station reaches from *Derry* to *Enniskilling*, where it crosses *Loughbearn* ; the next Station runs through Parts of the Counties of *Fermanagh*, *Leitrim*, *Longford*, *Westmeath*, and *King's-County* ; where it will meet with the inland Navigation from the *Liffey* to the *Shannon*, at about two Miles above *Banagher Bridge*. From thence through Part of the County of *Tipperary*, and by *Charleville* in the County of *Limerick* to *Cork*, which, computed on an Average, I take to be about 170 *Irish Miles*.

This Road I would propose should be 100 Feet broad from Quick to Quick (which is nearly the Breadth of *James's-street* in *Dublin*) the Ditches to be 5 by 6 Feet, planted with three Rows of Quicks, and the Top to be sowed either with furze or broom Seed, to preserve the Quicks from Cattle, and a Row of Forest Trees, planted ten Feet behind the Quicks on each Side ; and this Line also represents the front Line of the Houses, that may thereafter be built there, on making the Street, (for such it may with Propriety be termed) 120 Feet broad in the clear.

This Street is to be not only a Turnpike Road, but a Place to hold public Fairs, after the ancient Manner of the *Hanse* Towns ; to be held at such Times and Places as may hereafter be thought convenient. This Breadth of 120 Feet I would propose should be divided into 12 equal Parts, of which four Parts should be for the Carriage Way ; and next adjoining, there should be Houses of about 12 Feet broad erected for Watch-houses, Clerks, Weighing-houses, &c. occasionally, and in the same Range the Stalls should stand for the Chapmen to expose

their Commodities in Market Hours, and after to attend their Ware or Store-rooms, &c. &c.

When this Road is made, there ought to be large and strong mile Stones, with large, legible, deep-cut Figures, with foot Walks, finger Posts, &c. to begin at *Derry*, and end at *Cork*. And as it is not only to be a Place for the holding of Fairs at certain Times, but to be a constant Market, the Public should be accommodated with proper Ways to bring their Goods to it, either by Water or Land-carriage. The former is in several Parts of the Kingdom in great Forwardness, particularly the Navigation from *Newry* to the *Moy*, at *Charlemount-Bridge*. The *Canal*, from *Belfast* to *Loughneagh*, I believe, is very nearly accomplished; by which the Surplus of all the *British* Commodities to the Northwards may be easily conveyed to our Market; and the *Grand Canal* from *Dublin* to the *River Shannon* is now in great Forwardness; as are also the *Drogheda* and *Kilkenny Canals*. All these promise vast Advantage to our present Scheme. Then let it be observed, That (as the Public have been informed) the Flood-gates of these Locks are sixteen Feet wide in the clear, and the Locks 80 Feet long in the clear also, therefore proper Notice should be given to all our good Friends in *Great-Britain*, to prepare and make all their coasting Vessels agreeable to these Dimensions, and to draw five Feet Water; and these will carry about 50 or 60 Tuns burthen, and should have striking Masts. With such Vessels as these they may cross the Channel, and bring their Commodities to any Part of our Market they please, and deal and traffick with our Merchants, or such others as they either appoint or accidentally meet there, just as they think most to their Advantage. And I would also have it to be understood, that as our *Irish* Merchants may be supplied with all Kinds of Commodities, laid down at their respective Store-houses, they need not be at the Expence of building Ships of any Kind, except such Coasters as above described; and with these they may sail up either into the natural, or artificial navigable Parts of *Great-Britain*, and there change our native or other Merchandize for theirs, as Occasion may require.

But.

But as these few *Canals* are not by any means sufficient for these Purposes, we should also accommodate the Public with other Turnpike Roads, from East to West, which should meet or intersect our grand Road, and which would serve instead of *Canals*, until such Time as we can get them and others compleated for that Purpose.

I observed above, that the *Newry* and *Belfast Canals* were, or soon would be, compleated to the *Moy*, at *Charlemount Bridge*; from whence, in the mean Time, I would propose to carry a Turnpike Road, as near as convenient could be, in a direct Line to *Enniskilling*, which is about 32 computed Miles; where it meets with and intersects the grand Road, which I told you above was our principal Market; from thence I would have it carried to *Castlebar* and *Mayo*, thence to *Galway*, thence to *Limerick*, and from thence to the Grand Road. All those Roads that I have marked out with a single Line, I would have only 60 Feet broad from Quick to Quick; and no other of the new Roads ought to be less than that in the clear. That from *Dundalk* goes by *Cavan*, and crosses the great Road to *Abbyboyle*. That from *Drogheda* goes up by the Side of the *Black-water* near *Kells* to *Roscommon*: But the Road from *Dublin* to *Athlone* and *Galway*, ought to be of the same Dimensions of the great Road, viz. 100 Feet from Quick to Quick, or 120 Feet from House to House, or Tree to Tree, because it may be expected to be exceeding populous; for *Dublin* being the Metropolis, and in the Center of the East Side of the Kingdom, and directly opposite to the North-West of the trading Part of *England*, and also very convenient to the South-West of *Scotland*, Trade must certainly center in *Dublin*. In all these cross Roads the carriage Ways ought to be 30 Feet broad, and quicked, planted, &c. as mentioned for the great Roads; the Trees 6 Feet behind the Quick.

It may also be observed in this Plate (64) that the Road from *Dublin* to *Galway* is, by *Taylor* and *Skinner's* new Roads, 108 Miles distant, from *Dublin* to *Derry* 114 Miles, from *Dublin* to *Cork* 124 Miles; so that each of these are nearly of equal Distance.

Distance from *Dublin*, and quarters the Kingdom. Therefore, as I observed above, it is evident that Trade must center in *Dublin*.

As the Fairs, that we may presume would be held in this great Street, are one principal Part of my Plan for a *Free Trade*, I shall here offer a few Hints concerning Fairs in general.

The various Privileges of Fairs cannot be collected, but, “ the Privileges of free Fairs consists chiefly : 1st, In that all “ Traders, &c. whether Natives or Foreigners, are allowed to “ enter the Kingdom, and are under the Royal Safeguard “ and Protection, in coming and returning, they and their “ Agents with their Goods, &c. 2d, That those Persons, and “ their Effects, are exempted from all Duties, Impositions, “ Tolls, and Services. 3d, That Merchants, in going and re- “ turning from the Fair, &c. cannot be arrested, or their Goods “ stopped, &c.—It is the King alone that has Right, by his “ Letters Patent, to establish Fairs, whether free, or subject to “ Duties, and other Laws and Penalties, &c.—Several Fairs are “ held in the open Fields, or on Heaths and Commons, under “ Tents, and Barracks, erected for the Purpose, as *Stirbridge* “ Fair in *England*, &c. others in Places walled in for the Pur- “ pose, and formed into regular Streets, Lanes, &c. for the “ Occasion, as the Fair of *St. Lawrence* in *Paris*. Lastly, others “ are held in open Places and Streets of Cities, as *Bartholomew* “ Fair, *Bristol* Fair, the Fair of *St. Germain*, &c. Fairs, parti- “ cularly free Fairs, make a very considerable Article in the “ Commerce of *Europe*, especially that of the Mediterranean, or “ inland Parts of *Germany*,” &c.—Some Fairs hold for three Days, some for six, some for a Fortnight, or three Weeks.— “ The Fair of *Beaucaire*, held partly in the City of that Name, “ in *Languedoc*, and partly in the open Country, under Tents, “ &c. it commences on the 22d of *July*, and only holds for three “ Days ; yet it is the greatest, and most celebrated of all the “ Fairs in that Part of *Europe*, both for the Concourse of Stran- “ gers from all Parts of the World, and for the Traffic of “ all

“ all Kind of Goods. The Money returned in these three
 “ Days amount sometimes to above six Millions of Livres.”
Chamb. Dict.

Although I have quoted these Notes, I have not taken any one of them as a Precedent, but I rather suppose that at some Time hence we should have one Fair in each Year, extending from *Derry* to *Cork*, during the Month of *June* or *July*, and move on to *Maynooth* and *Leixlip*, where the Fair ends; and such as have Business may afterwards meet with their Correspondents at the *Royal Exchange*; and so the *British* and other Merchants, Agents, Factors, Chapmen, Dealers, Pedlars, &c. may meet at any appointed Place in these great Roads, to vend or exchange their Commodities with each other, or to collect them for the several Merchants, or others, who may employ them throughout the Kingdom, and there close Accounts.

And as to Markets, I suppose that the whole Kingdom is to be a MART, and that the main Road, or Street, between *Derry* and *Cork*, should be, as it were, the Seat of Trade, that is the *Market Street*, for Manufacturers of all Kinds, and for the Residence of Agents, Factors, Chapmen, Dealers, Pedlars, &c. as above mentioned; whose Business it will be to buy up and to collect all Sorts of Commodities, and to hold themselves in Readiness at all Times, on the shortest Notice, to answer the Calls of either our *East* or *West* Merchants, so as they may, with the greatest Punctuality, supply the Calls of the *East* or *West-India* Merchants, or their Correspondents in any other of the *British* Merchants Companies, there or elsewhere; so that not only our native Commodities, but all other *British* Merchandize sent to our Market, may be immediately exported to foreign Markets, and either Cash, or Goods returned for them, as is usual in a commercial Trade. But further, I am fully convinced, that not only these few Roads I have mentioned above, but if there were still more of them, that would cross or enter into the great Street, they would all be suddenly inhabited by Artists, Tradesmen and Manufacturers, of various Denominations, provided that the Proprietors of the Lands they went through, or their Agents, would

take proper Care to make Preparations for them: But particularly, in observing and choosing choice Situations for Towns, either for interior or exterior Trade, &c. and if that Choice was judiciously made (on which I intend to treat hereafter) there may be the greatest Hope conceived, that within a short Period of Time, numerous new and opulent Towns and Cities may spring up, wherein Ground may set per the Foot Front, and perhaps some of them out of wild and waste Ground, which at this present Time is in a Manner useless to Mankind.

I have said above,—the Roads that would cross, or enter into this great Street, would perhaps be suddenly inhabited; but I must add, that in any Parts of this Kingdom, even in those that are the most remote and unfrequented, the making such Roads (60 Feet broad from Quick to Quick) would soon discover such natural Advantages to a judicious or discerning Eye, that might create such a Populousness, as might vie with some of those in the most opulent Parts of the Kingdom, and thereby greatly increase the Revenues of the Proprietors.

These interior Improvements will also answer many other salutary Purposes; as for Instance, *Dublin, Cork and Carick-on-Suirr* are noted for carrying on large Manufactories. Their Journey-men have often complained loudly for want of Work, and always have been demanding a *Free Trade*, &c. Now indeed, they are gratified to the utmost of their Wishes: Yet there are many sensible People, that conjecture, they will not be content when they see Manufacturers of their respective Professions brought into their Places of Residence, to follow their own Employments, either as Masters or Journeymen; and then forsooth, they must rise up in a riotous Manner to ruin or expel them; not having Sagacity enough to know, that it would be more prudent to give them a hearty Welcome, and use their best Endeavours to learn all their Ways of Working, and, if they can, to excel them, rather than to drive them away. The evil Consequences of such rude and injudicious Behaviour may be easily foreseen, if they were to consider the Preparations which I have just mentioned for their Reception, in numerous other Parts of the

the Kingdom, which by their ungenerous and unjust Behaviour to Strangers, may tend toward drawing on the Ruin of their own Place of Residence, and also destroy and lessen the Properties of their Families.

But there is another Thing, which I could wish that they and such other discontented People would consider, *i. e.* the Insignificance of all Kinds of Work that can be done in this, or any other Town, or City in this Kingdom, nay, not in all the Towns and Cities in it, if there even were ten for every one that there is now in it, when compared to what our own Merchants could find Vent for through the World; and so by endeavouring to keep all the Trade to themselves, they may fitly be compared to the Dog in the Manger.

As there may be many Objections to these Fairs, let it be understood, that I do not suppose they would, or indeed could take Place, till there were proper Preparations made for them; and therefore whether they take Place or not, they cannot have any disagreeable Effect on my Plan, because the Market will abundantly answer our Purpose; for the Market is to hold all the Year round, *Sundays* only excepted; nor can there be any Objections made to that. As for Instance: If a Shoe Manufacturer has a Parcel of Shoes ready for Sale, any Man that comes to his House on a Week-day to buy his Shoes, he has an undoubted Right to sell them; or if the Shoemaker brings his Shoes to the House of a Factor or Dealer, and gets some Money and some Leather for them, they have an undoubted Right to buy and sell as they please, because it is an established Law, *that every Man's House is his Market*; and on the same Principles the Factors or Dealers may traffic with their Merchants, who may carry on their Exports or Imports all the Year round; and consequently, according to this Plan, the whole Kingdom may be properly called THE IRISH MARKET.

The public Utility that will attend this Market-street is obvious. For Instance: If any Tradesman, or Manufacturer, in or on either Sides of this Street, falls short of Money to pay his Men on *Saturday* Night, it will be quite convenient to him to apply

apply to the Factor he deals with, and get what he wants, either of Money or Materials, to answer his Purposes. And it may be also observed, that if the respective Manufacturers that settle in any of these Roads, or other interior Parts of the Country, do make a judicious Choice of a Place for their Business, and have a Capital sufficient to carry it on, they will have their Land at a cheap Price, Room in Abundance, Fire, Water, and numerous other Conveniencies; from whence it is evident, that they may get far greater Gain by their Business, and undersell those that live in Towns or Cities under heavy Rents, Taxes, &c.

I shall mention another Advantage that will accrue to such Persons as settle in this great Street, *viz.* the public Granaries, that are to be erected at certain Distances in it, which are to contain at all Times at the least one Year's Provision of Bread for the whole Kingdom; so that the Tradesmen, and all others, either from the East or Westward, may be speedily supplied at moderate Expence: And beside all these, and numerous other Advantages, we must not forget to observe, what additional Beauties and delightful Prospects will most assuredly be discovered, and in a short Time produce numerous elegant Buildings, extensive Improvements, delightful Villas, and in short, adorn the Works of Nature to such a Degree, as may make this Kingdom a Kind of Paradise, for Health, Wealth, Pleasure and Delight; and all these may be obtained without encroaching on a sufficient Proportion for Agriculture and Pasture, and every Part judiciously disposed of with respect to the Distribution of the Whole.

C H A P. XIX.

On the frugal and effectual Management of several useful Matters and Things relative to our general Plan.

FRUGALITY is a Virtue that all well-meaning Men generally wish to possess; and yet, perhaps some of them do often mistake their Object, and are carried away by the Impulse

pulse of their Imagination without the Consent of their Judgment; by which they become prejudiced in Favour of some particular Object which they did not at first intend, and are thereby led into extravagant Expences. This perhaps may be my own Case. I feel myself violently inclined in Favour of these two great Roads, because I imagine that they will be of infinite Advantage to the Public, and by frugal Management may be accomplished at a meer trifling Expence when compared to their public and private Utility. But of these two great Roads, one of them has engaged my warmest Attention, far above the other, on which I shall now begin to treat, and leave my Reader to form a cool and unprejudiced Judgment on it.

S E C T. I.

Concerning the great Road from Dublin to Galway by Athlone.

I AM fully convinced of the Utility of the great Road I have designed from *Derry* to *Cork*, provided there are not any material Obstructions in the Way. But that is a Matter of such a Nature, that no Person can expect I should seriously recommend it from a bare Inspection of such incorrect Maps as are now extant. Where I have drawn the Lines, there may, for aught I know, be huge Mountains, or some other insurmountable Difficulties, that might put the Public to exorbitant Expences. But that is not the Case with respect to the Matter in Hand; for I am fully satisfied, That I may safely rely on the Map I have perused, and the Informations I have received on that Head.

About eight Years ago I accidentally got Mr. *John Trail's* Map and Report of the *Grand Canal*, and I often perused it, not only by Way of Amusement, but because it opened a new Train of Thoughts to my Attention: For as I was intent on forming Schemes for the general Improvement of the Kingdom, I clearly perceived that that Map pointed out the very Thing I wanted for that Purpose; and as the Whole of that Report shewed his great

Capacity, his Map was a still farther Proof of it. I shall therefore proceed, and endeavour to point out such Matters as I think may be useful to our young Surveyors in future.

As the Works of the *Canal* have gone on so exceeding slow, I conceived that it would be very useful to make an elegant Road from *Dublin* to *Athlone* and *Galway*. I shall now mention some Difficulties which may perhaps be met with, and point out some Methods to conquer them.

The Road from *Dublin*, with proper Improvements, must remain as it now is till you come to *Leixlip*, after which you must keep to the Westward of the Obelisk, and pass about 107 Perches from the South East of the Castle of *Manooth*, and following that Direction, in five Miles and a Half further, you will have an Arm of the *Bog* of *Allen* to cross, and then you keep in the same direct Line till you come to *Castle Jordan*, and from thence to *Tyrrel's-Pass*; then crossing the *Brusna River*, you go on (I imagine) in the same direct Line to *Athlone*: All which you may clearly perceive in Mr. *Trail's* Map, and by it you will find that that direct Line will measure about 45 *Irish* Miles, all nearly on a Level.

After you have laid out and got the *Philipin Sod* turned up, so that you may be sure of your direct Line, the first Difficulty you may expect to meet with will be that Arm of the Bog, which is about one Mile and a Half broad, which you must see bored and take the exact Depths, and then you will be able to form a Judgment with respect to the Methods which you are to pursue in that Part of your Work: And although it may be very soft, that Circumstance need not discourage you, as you have such a Variety of Methods laid down in the second Part; but I would not recommend it to you (as not being accustomed to such Works) to encounter with more than 10 or 15 Feet; but be the Depth more or less, I can confidently affirm you will meet with either a marly or a firm gravelly Bottom; and you must not only examine this Part of your Work, but all other Bogs or Marshes which your Work is to go through before you enter upon it: For it will make you an Object of Ridicule if you begin it, involve the Public in considerable

considerable Expences, and then come and tell the Gentlemen of your Board, that you find it impracticable. Therefore, before you begin the Work, make a just and correct Estimate of every individual Part of it.—I should not indeed say so much on this Head, but in order to prepare you for such Difficulties in future, and especially as there must be a Bridge built in this Arm of the Bog, being the Source of the River *Blackwater*, which empties itself into the *Boyne* River, and I am glad to have an Opportunity to set you right in this Matter: For although Plate 41, page 121, is designed for such difficult Parts of Roads, yet I do not pretend to say it will answer all Purposes, nor is it likely to be necessary for this Place, because Nature has pointed it out as one of the Places by which that Bog may be partly drained; and to that End you must build the Bridge in such Manner, as it may not prevent, but rather further the Draining of it, to effect which most desirable Purpose, I shall now mention a few Particulars.

As I do not know the Texture of that Ground, I shall prepare you for the worst; and Reason will tell you, that if the Work of draining that Bog takes Place in future, your Piers ought to be sunk a considerable Depth, so as to admit of the greater Fall from it. I shall therefore recommend another Method, so that you may take that which you think will be cheapest and fittest for your Purpose: In order to which, it is now become necessary to explain, what I only glanced at in page 120, Sect. 2, on a Road made by the *Romans*, which I found mentioned by many of their Historians, and particularly in *Bowen's Geography*, Vol. 1st, page 1009.

“ *Esseck* or *Murcia*, near the Borders of *Hungary*, is a Place
 “ of great Antiquity—It is a large populous Town, 5 Miles
 “ from the *Conflux* of the *Danube* and the *Drave*, 40 East from
 “ *Valpo*, 87 North from *Belgrade*, and 103 South-East from
 “ *Buda*. ’Twas particularly remarkable for its famous Bridge over
 “ the *Drave* and some *Morasses*, which was eight Miles long, and
 “ near 30 Yards broad. It consisted of thick Planks of Oak,
 “ supported by 9 or 10 great Trees in a Row between every
 “ Arch. *Dr. Brown* says, ’twas railed on each Side, had watch
 “ Towers

“ Towers at the Distance of every Quarter of a Mile, with
 “ Stairs to the Marshes on both Sides, and was upon the Whole
 “ a very beautiful and stupendous Piece of Workmanship, but
 “ destroyed by the *Imperialists* in their late Wars with the *Turks*,
 “ who used to invade *Hungaria* by this Bridge.”——Considering
 therefore this Method, along with the various other Methods be-
 fore laid down, you may form your Designs, so that your Work
 may prove cheap and stand substantial for Ages to come; but if
 you find that this will be the most adviseable Method, you are to
 consider that Oak, or even *Norway* Fir, will be very expensive,
 and provided you can get good large *Irish* Fir that has been fallen
 in *June*, I think you may safely venture to use it for Posts or
 Piles, for this or the like Purposes.

Within about 7 Miles and a Half from this Arm of the Bog,
 you cross the *Boyne*, which issues from the same Bog, where you
 will also want another Bridge perhaps a little troublesome, as it
 will be at the South End of a Bog that begins near *Kinnagad*, but
 not by any Means so difficult as the former. In four and a half
 Miles further you enter on another Bog, which will not want
 any Bridge, nor perhaps any Kind of Difficulty in going on with
 your Road, till you come to *Tyrrel's-Pass*, nor even there, be-
 cause you can easily make a Road across the End of the Bog that
 comes from *Lough Ennal*, and then you come to the River *Brus-*
na, which must have another Bridge, and from thence, as I con-
 ceive by an accurate Map of the County of *Westmeath*, you will
 not meet with any Observation worthy of Notice till you come to
Athlone; and thus upon the Whole, from *Leixlip* to *Athlone*,
 which is 45 Miles of level Ground, you only have three Bridges,
 of an insignificant Nature in such an extensive Work.—And the
 firm arable Ground on which you are to work, I can assure you
 on the Word of Mr. *Evans*, is of a firm gravelly Nature.

Here let me change your Attention, and entreat you to reflect
 on the Beauty and Utility of a Road of 100, or a Street of 120
 Feet broad in the Clear, all in a true direct Line, and nearly on
 a Level the whole Way, and on a firm gravelly Bottom with neat
 clipped Hedges and Forest Trees planted on either Sides, or built
 with

this Kind, which is calculated also as a safe Communication and a speedy Convenience, in a direct Line on level Ground, to and from the *Atlantic Ocean*.

But as Frugality, in all Kinds of Affairs, ought to be considered along with Utility ; let us observe how pleasing this Road from *Dublin* to the *Shannon* must be to the Public. Mr. *Trail* has told us in page 21, that the total Expence from *Dublin* to the *Shannon* River will amount to 100,368*l.* 13*s.* but when that Work will be accomplished, no Man can tell ; and as it has appeared that our Road may probably be made, exclusive of the three Bridges, for - - - - - *£*4500
 And admitting that these three Bridges would cost - - - 300
 And also the Improvements of the Road from *Dublin*
 to *Leixlip* might cost about - - - - - 200

*£*5000

Then this commodious and delightful Road, by proper Management, might be accomplished (if required) within the Space of one Year for about 5000*l.* and so admitting of Errors on both Sides, the Proportion as to Expence will stand : As 5 to 100, or as one Shilling to one Pound ; with the greatest Deference therefore I recommend this among other Matters to the Attention of those whom it may concern. Hence I infer : 1st, That, the more commodious the Roads are, the more Wealth will accrue to the Inhabitants. 2d, That the most rude and unpopular Lands stand in the most Need of Roads to and through them. 3d, That improving the most minute Part tends to advance the Whole. Let us in the next Place consider some few Matters relative to reclaiming Ground, flooded either by fresh or salt Water, or Draining of Bogs.

S E C T II.

On reclaiming Ground.

I N our Books on Agriculture and others, there have been many Methods laid down for this Purpose ; but as I have not been much acquainted with Works of that Sort, I shall only just point out a few Matters to your Attention, which, I presume, are not mentioned in any of them. In Plate 40, Chap. 16, page 118, you have a very ready Method for a fresh Water Lake ; but I was deficient in not recommending the Use of Floats to help the Cars and Carts, as they would be much cheaper, and more expeditious, especially if you can get convenient Banks for loading them ; and this Method is easily reduced and made proportionable to any lesser Depth of Water. But in Case you are required to reclaim Ground off the Sea, you must take your Method from Plate 28, page 87, filling up the Vacancies between the outward Joinings of the Coffers between the Belts, and banking with hard Stuffing without, and by making it a substantial Rampart on the Inside next to the Land, so that the Water may not penetrate under it. On this and the like Works you may collect other great Helps for this Purpose from what you have seen in Chap. 17, &c. I shall now give a few Hints concerning the Draining of Bogs, in which I have had some little Experience. And on that, and on all I have either heard or read, it appears to me that there is generally one Error in the first setting out : Gentlemen that have Bogs to drain, do indeed, for the most Part, take Time enough to consider of it before they begin ; but when they are once determined, they rush upon it precipitately, and set Labourers to open Drains in different Parts of the Bog ; whereas the first Thing that ought to be done, after making the main Drain to carry the Water off, is to broach the Bog, by running a Drift into it, answerable to the Fall of the main Drain, as far as they can ; and if it is a quaking or a wet Bog, the only Trouble that will be necessary is to keep that Drain clear, and to allow

allow it Time to do its own Business : And when they advance further into it, and find it difficult to keep the main Drain clear, let them drive down any common, but pretty straight Sticks, within two or three Feet of each other, and stretch any Kind of green Branches behind them, and *brace them asunder* with other Sticks at above six or seven Feet high ; and then, as I told you before, let the main Drain be kept open, and if the Banks are high, use two long Planks and Box-barrows, &c. and in Time you may accomplish your Work, perhaps for the tenth Part of the Money that might by some other Methods be spent upon it ; because if you help Nature, she will go on with her own Work. Therefore when you have adjusted the Levels, and marked out such Place, or Places, as you find properest to begin these Advances, and given the Labourers (in whose Province such Works are) these Directions, you only need to cast an Eye on it at convenient Times, in case the Proprietor is absent or above attending to his own Interest.

C H A P. XX.

Some brief Propositions, tending to a concise Summary of the Whole, and pointing out easy Methods for the Accomplishment of this Plan, and demonstrating its great Utility.

S E C T. I.

Concerning the Surveyor or Supervisor of these Works.

A PERSON proper to supervise these Works ought to possess the following Qualifications : 1st, He must be extremely well versed in the practical Business of a Surveyor of Land, in all its various Branches, and be able to produce Specimens of his own Works actually performed with his own Hands. 2d, He must be sober, diligent, and strictly honest. 3d, He must be healthy, active, able and willing to undergo the most laborious Fatigue that can properly relate to the Business of

of his Vocation, and give due and personal Attendance to it. And it may be presumed, that no Gentlemen will use Means to impose on the Board, by endeavouring, through their Influence, to put any Person into such a weighty Employment who doth not enjoy these, or the like Qualifications. This ought to be strictly observed, because many weighty Matters will depend on it.

S E C T. II.

On some practicable Methods, humbly proposed for the easy Accomplishment of the foregoing Plan.

IT has been handed down as a Proverb, that when a Work is well begun it is half ended; and perhaps the Meaning is, that when a Work is previously well considered it may probably be well finished. And sure there are no Works that ought to be more effectually executed than public Works, in which every Individual is, or at least thinks himself more or less interested; and therefore in many Cases People freely offer their Opinions. I shall, therefore, without any further Prefacing, lay my Sentiments on this Matter before you. Let us then suppose, that before our Parliament is prorogued, that they should appoint a Committee of both Houses, to continue sitting in such Manner as they think proper, till three Months after the Meeting of the next Sessions of Parliament, and to have Power to take such Steps as may appear most advisable to them toward the general Improvement, and the commercial Interest of this Kingdom, and to draw on the Treasury for such a Sum, or Sums of Money, as they may find necessary from Time to Time, within a certain limited Sum, which, by-the-by, need not be very large, because the Money that will be needful, ought chiefly to be expended in making proper Preparations against the next Sessions, so that every Member of both Houses may have an Opportunity to consider, and to approve or disapprove the then intended Designs as they think will be most advantageous to the Public, and then to pass such Acts as they may think necessary.

When the Committee is so appointed, and have Power to act, I presume their first Step ought to be to appoint local Committees throughout the Kingdom, or such particular Parts of it as may seem necessary; and that these local Committees should be chosen, and double Numbers returned by the Grand-Juries or High-Sheriffs of Counties, the principal Magistrates of Cities, or corporate Towns, or the Ministers and Church-Wardens legally assembled; and that these local Committees are to consider all such Matters and Things as may be directed to them by the grand Committee, particularly relative to all Plans, Schemes, Proposals, Estimates, &c. in any of their several Districts.

These Matters being put in the Way of having a due Consideration given to them, the next Step ought to be the Procurement of such a Surveyor, or Supervisor, as is above recommended; and to give him Orders to enquire for, or procure other compleat Surveyors, to go on with and finish all the Counties that have not as yet been fully and minutely surveyed, and to take Care that they are delineated with great Exactness, each on a Sheet, or more, of Imperial Paper, dotting out the Mears and Bounds of all the most considerable Estates, shewing the Bogs, Loughs, Heaths, Mountains, Rivers and various other Things as may appear worthy of Attention, particularly observing, what I have already slightly recommended in the latter End of page 162, &c. to wit, to get correct Surveys made of the Coast quite round the Kingdom, &c. and that these should be minutely inserted in the Surveys of the Counties at large, and be correctly laid down in the four Sheet Map as also before mentioned, and the Reasons assigned for it in page 163, by which Means any Gentleman that pleases can have an Opportunity of perusing them, and not have Reason to imagine that he has been overlooked, nor that other Gentlemen have gained the Attention of the Board further than what Time, Place or other just Circumstances might have entitled them to expect: And therefore it is necessary that before the grand Committee can determine on the Propriety of any Scheme, either for the interior or exterior Improvement,

provement, it ought to be laid down on these large Maps for their Perusal.

Hence it is evident that the grand Committee will not have Occasion for much Money at present, nor, according to this Plan, in future, except for Bridges, and the Improvements of the Ports or Harbours. For I have already shewn in Chap. XIX. Sect. I. page 177, that the Expence of inclosing of Roads is in a Manner insignificant, and on these depend the principal Parts of our Plan, which need not engross much of the Time of either the grand or local Committees to consider the public Utility that will accrue from them where the Expence will be so trifling, by Reason of our whole Kingdom abounding with excellent Materials for the Purposes, which will agree exactly with the present low State of our Finances, and all Kinds of expensive Improvements may be deferred till we are in better Circumstances, and a new Policy established in the mean Time; and that Kind of Trade and Commerce which we have been endeavouring to introduce, may instantly take Place; and all the lower Ranks of People settled to work on our present System of public Affairs. Let us in the next Place endeavour to demonstrate the public Utility of our Plan.

S E C T. III.

On the public Utility of this Plan, and briefly demonstrating that, not only Great-Britain and Ireland, but also the whole British Empire may gain mutual Advantages thereby.

THE Advantages that most certainly may accrue from this Plan, I shall distinguish under these three Heads: 1st, The landed, 2d, the commercial, and 3d, the *British* Interest. 1st, The landed Interest may principally appear by considering the Value of Ground that is now set to poor People by the Acre: And supposing the same to be set to opulent Tenants in small Farms of well-improved Parks, or in Lots at so much a Foot front, which by this Plan may most certainly be the Case in many

many Places quite over the Kingdom, &c. 2d, The commercial Interest may be conceived, by considering, that this Kingdom will be a Market Place for all the mercantile World, and that the Wealth of numerous Nations may be brought even to the Doors of our Merchants, without going to the Expence of Importation, and all our native Commodities brought to their Hands ready to be given in Exchange for them, &c. The real Interest, and some of the Advantages that will occur to *Great-Britain*, I shall now briefly consider. 3dly, I presume it has already appeared evident through the whole Scope of my Plan, that I have not studied any Thing more than the permanent Tranquillity of his Majesty's Subjects in general ; yet it may be necessary to support my Argument, by demonstrating, that not only these Kingdoms, but also the whole *British* Empire may gain proportionable Advantages by our Plan ; therefore, for Fashion Sake, I shall endeavour to draw a few concise Conclusions from the Whole.

FIRST CONCLUSION.

That totally abolishing all Associations of Non-importations from *Great-Britain*, and opening a daily Market for all Kinds of *British* Commodities, is an evident Advantage to them.

SECOND CONCLUSION.

That as our own Merchants may at all Times be stored with our staple Commodities, it will be advantageous to Government to know where their Fleets and Armies may be immediately supplied with Provisions on any Emergency.

THIRD CONCLUSION.

That the *British* Merchants Companies may gain some Advantage, by having our Market at all Times open for them, to vend such Merchandize as lye on Hand, and get our native or other

other Commodities in exchange thereof for the Use of their Settlements.

FOURTH CONCLUSION.

That the Wealth of *Ireland* centers in *England* is a Maxim indisputably established, and consequently the Wealth of *Ireland* is the Wealth of *England*.

FIFTH CONCLUSION.

That by the Population of *Ireland*, his Majesty may be readily supplied with stout trusty Soldiers and Sailors on any Emergency, who will valiantly support the Dignity of his Crown throughout the World.

SIXTH CONCLUSION.

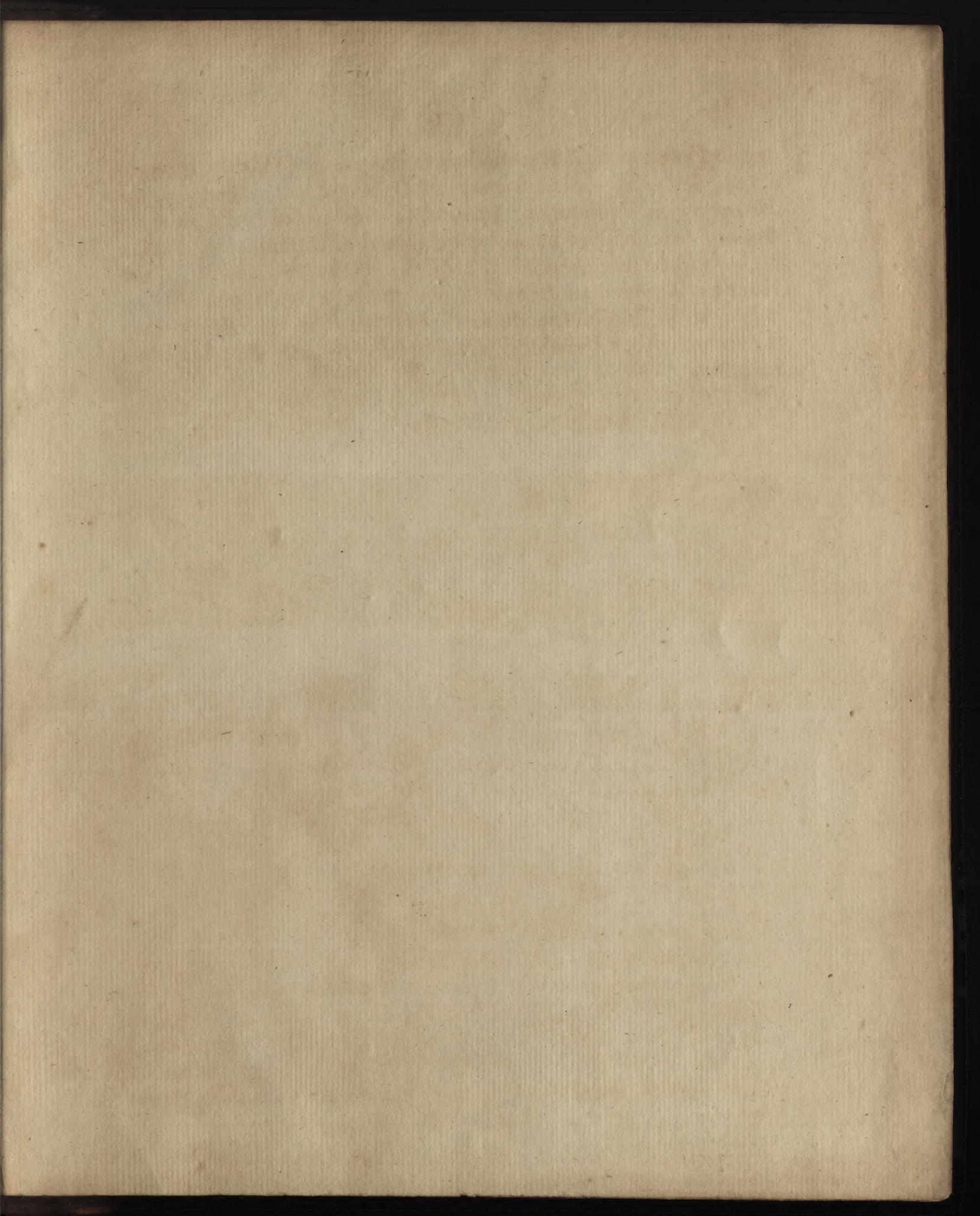
That his Majesty has had recent Proofs of the intrepid Courage of his true and loyal Subjects of *Ireland*, who, on the first Whisper of an intended Invasion, instantly entered into military Associations, and resolutely determined, that they would hazard the Shedding of the last Drop of their Blood in the Defence of his Kingdom of *Ireland*.

SEVENTH CONCLUSION.

That as a fatal Quarrel happened between *England* and our Friends and Relations in America, let us, who are placed by Providence between them, use our utmost Endeavours to alleviate their Misfortunes, smother all Animosities, and invite our Friends on both Sides to come and meet each other at our MARKET, and to carry on a friendly Traffic with each other in future, and to partake of the Benefits that may arise from our *Free Trade*;

and in Case a perfect Reconciliation cannot be suddenly brought about, let us nevertheless take all Opportunities to engage the *Americans* to continue our Friends, and in perfect Alliance with us ; and then shall we be as it were a Bond of Union between them both, and act the good Part of Peace-makers : And when the Hour of Reconciliation arrives, we shall be again one People, able and willing to maintain the Dignity of the *British* Flag throughout the Universe, in Despite of all his Majesty's Enemies.

F I N I S.



63 plates + folding plate + map

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